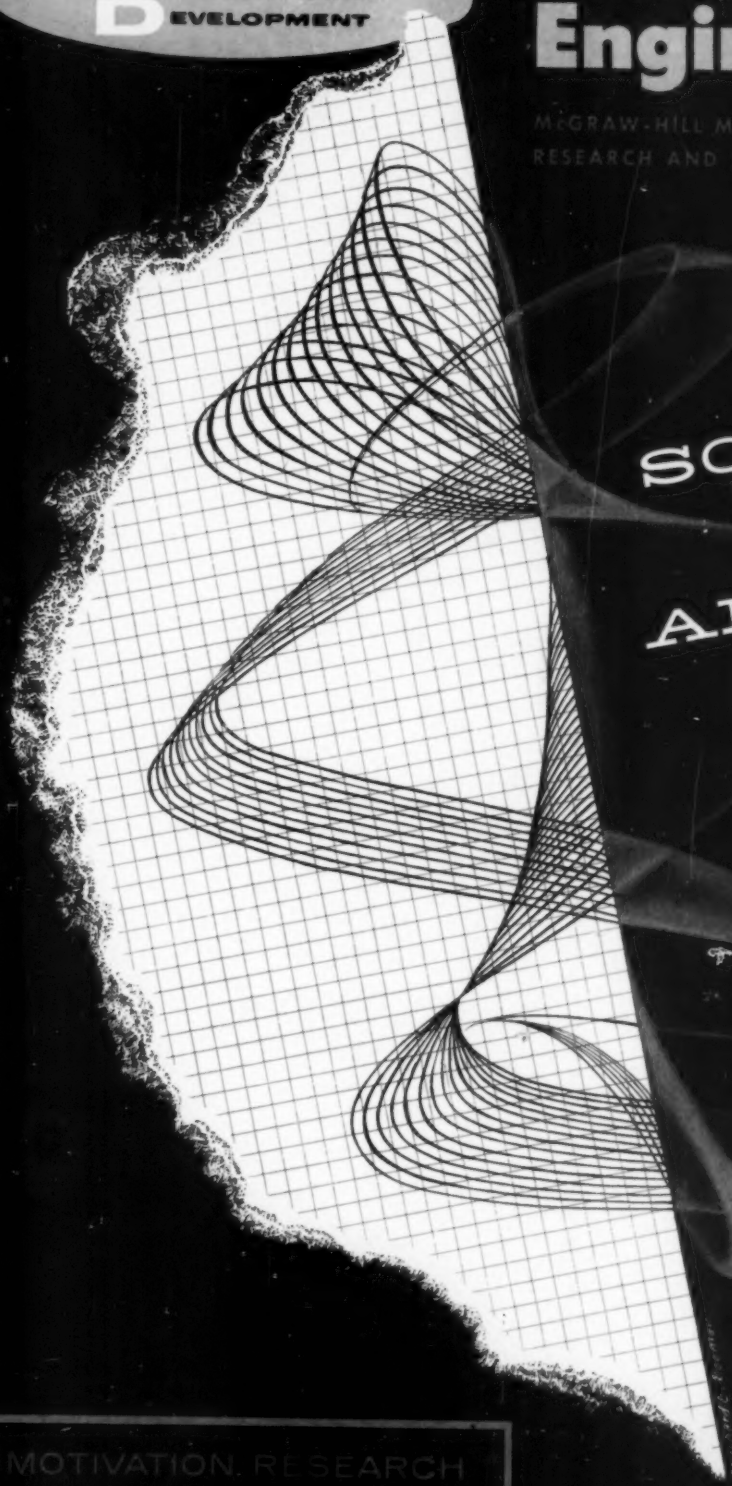
JANUARY 26, 1959

R ESEARCH
and news issue
D EVELOPMENT

Product Engineering

McGRAW-HILL MAGAZINE OF DESIGN
RESEARCH AND DEVELOPMENT



SOLUTION BY ANALOGY

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MOTIVATION, RESEARCH AND DESIGN page 40

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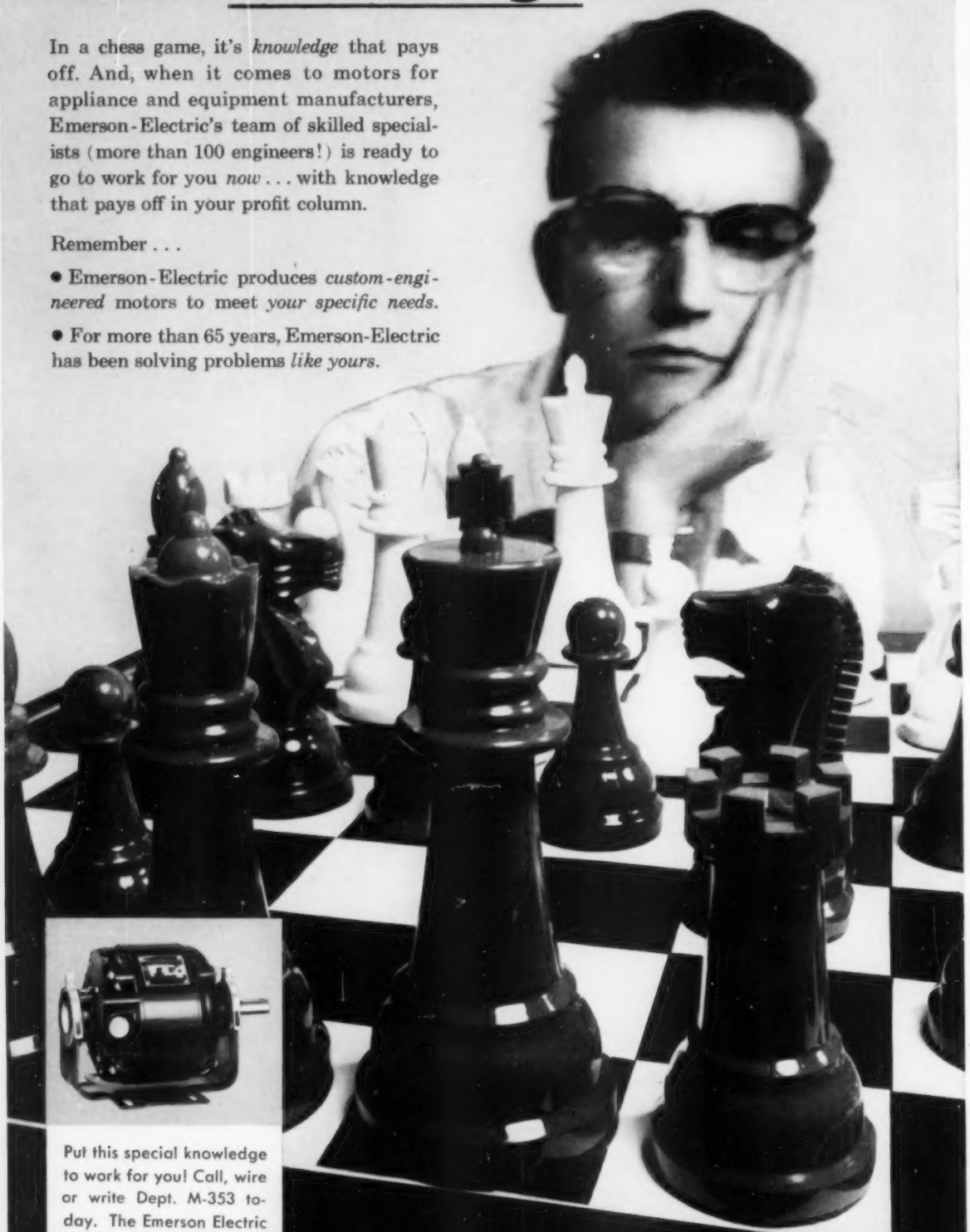

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YOUR INDEX IS NOW READY

A 16-page printed index of all editorial content in issues of the last six months of 1958 (Vol. 29) is now ready. Copies may be obtained by writing **Index Vol. 29—2** in the space marked "Special Data" on the Reader Service Card, p. 51.

The index is issued twice each year in July and January and copies will be sent free on request as long as the supply lasts. A limited supply of the index for the first half of 1958 (Vol. 29—1) is still available.

coming next week . . . the DESIGN issue for February 2

FEATURING

- **Reliability of electrical connections**
  An industry consensus on soldering, crimping, welding, clamping, wrapping and others.

- **Product design for –300 F**
  Materials embrittle, moving parts "freeze", lubricants congeal—an introduction to low-temp design.

- **Power cylinders**
  Charts give safe piston-rod size for strokes of 10 to 300 in. in 5 mounting styles.

- **Graphical synthesis of four-bar linkages**
  Methods that simplify development of linkages to generate specific functions.

- **Copper alloys for small tubular parts**
  Easily drawn, swaged, flared, pierced, bent and joined—these alloys can solve many design problems.

- **Selecting plastic laminates for punching**
  Punching ease of various laminates and their mechanical and electrical properties.

- **12 ways to retain gaskets**
  Bolts, spacer plates, recesses, welded channels and other arrangements.

Product Engineering

McGRAW-HILL MAGAZINE OF DESIGN, RESEARCH AND DEVELOPMENT

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Product Engineering ..... SIDELIGHTS

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● **Say "computer"** and one immediately pictures sleek cabinets in muted colors, flashing lights, switch banks and artful sprays of color-coded hookup wire (p. 36). Combine this self-satisfied look with a formidable ability to solve problems (p. 28) and you have created a Frankenstein's monster that may well make people obsolete. This is no idle joke; two recent news stories have started us on a train of night thoughts that made sleep just a fond memory. The first was a report from MIT. Studies in language and translation have gone so far that MIT's computer now "has a vocabulary larger than that of Winston Churchill." The machine is not yet ready to start a new "History of English Speaking Peoples," but that will come too. The second report concerns a Dr. Lajaren Hiller, assistant professor of music at the University of Illinois. He hooked up a digital computer to compose a four-movement piece of music called the "Illiac Suite for String Quartet." If seems music professors aren't indispensible either.

● **The new Purdue curriculum** (p. 19), designed to prepare engineers for graduate work, seems ideally suited to a predicted wave of inventiveness. Dr S Stewart West, a social scientist with the University of Michigan, has found a cyclical pattern in scientific discovery, with a peak every 164 years. He predicts the next crest in 1973 and the next "major minimum" around 2055. If the first half of this century is only a buildup just imagine for a moment the promise of the next 50 years—assuming, of course, there's some one around to enjoy it.

● **A new parts specification** for drawings has just come to our attention and we'll pass it along without comment. (After all, our sister publication, *American Machinist*, is edited just down the hall.) The spec number is MILTDBP—41. Or, spelled out in detail: Make It Like The Damn Blueprint—For Once.

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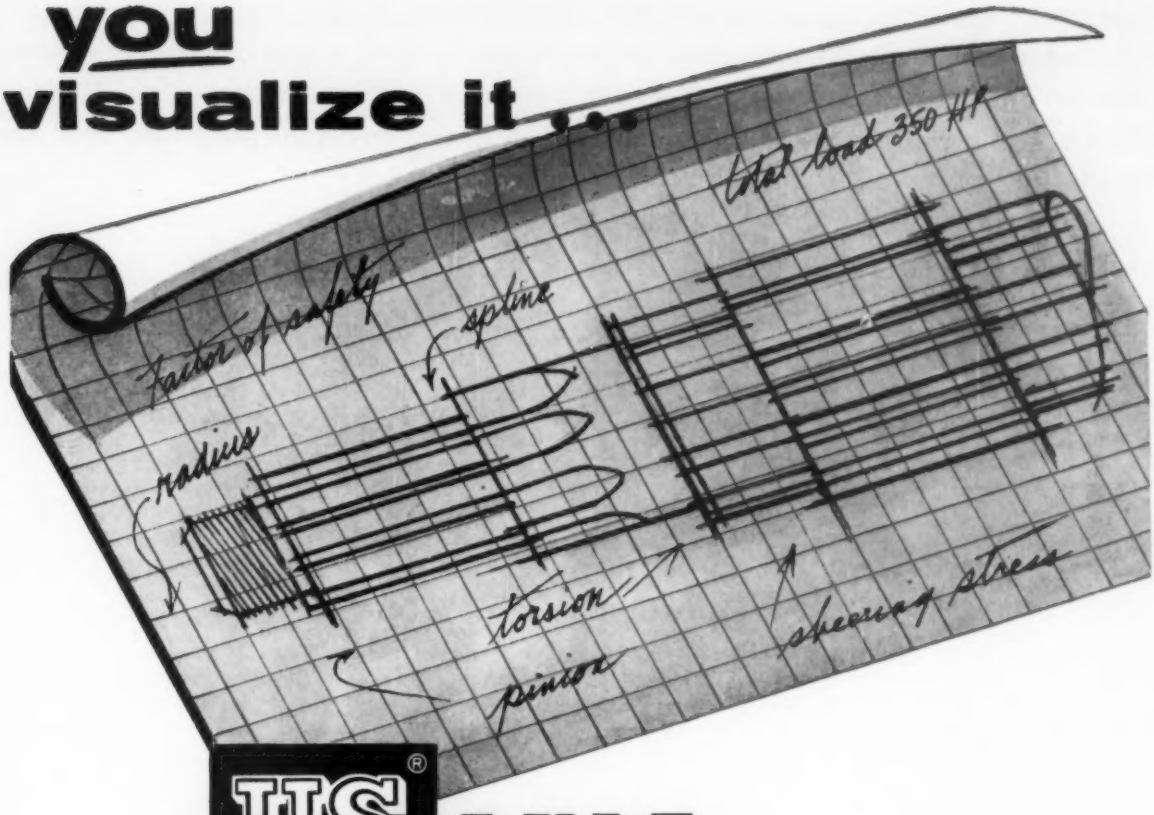

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DEVELOPMENTS TO WATCH...

American

Electric cars and trucks are coming back . . .

. . . says M. G. Smith of Electric Storage Battery's Industrial Div, and there's evidence he's right.

Exide itself has been working with Cleveland Vehicle Co for some time on the development of an electric delivery truck for house-to-house service; says it's now almost ready for the market. According to Smith, in economy of operation and maintenance it's expected to "outstrip anything but a bicycle."

Meantime Stinson Aircraft is readying its Charles Town-About using rechargeable selenium batteries, (*PE*—Nov 24 '58, p 27) for commercial introduction this spring. It's said to have a top speed close to 60 mph; a range of 80 miles.

Electric power companies, always interested in new devices that use electricity, are also sponsoring development of electric autos that can be "plugged into any outlet" for recharging. Washington Water Power Co, for instance, is reported to have an experimental model well along in development.

Half a dozen new printing and reading machines . . .

. . . for microfilmed engineering drawings will be introduced by Filmsort Co in the next few months.

Scheduled for February are three readers, one small and two of larger size, and a combination diazo exposure and development unit.

On March 1, the company expects to offer a revised and improved semiautomatic Optical Mounter with a new film-feeder and a new film-advance.

Coming up in September is a fully automatic card-to-card diazo, now in the prototype stage.

Ceramic vacuum-tube headers with tantalum pins . . .

. . . are being made available "in limited quantities" by American Lava Corp. These are 7 and 9-pin units, hermetically sealed to alumina bases and envelopes. Nickel is the brazing alloy.

The materials, American Lava says, have been specially chosen for their low vapor pressure as well as their heat resistance, and allow higher bake-out temperatures during assembly.

Color TV projections as big as 12 by 16 ft . . .

. . . and black-and-white pictures to 24 by 32 ft are possible with a Swiss-developed system, soon to be made commercially here.

Known as the "Eidophor" projector, it was demonstrated at the recent AAAS meeting by Ciba Corp, which is sponsoring its introduction and commercial development.

With the system, Ciba reports, "it is possible to achieve a contrast of 100 to 1 . . . equivalent to the degree of contrast obtained with good film projection."

The Eidophor system differs in several respects from the Schmidt high-intensity electronic tube method. Eidophor is essentially a relay system, based on electro-optical *control* of the light beam from an outside source, rather than on electronic *generation*. Says Ciba:

Electrical impulses from the camera control an electron beam which bombards, and thus modifies the surface of a film of oil on a concave mirror. Light passing through the resulting "wrinkles" in the oil film is projected through a special grating onto the screen. Light output is, therefore, limited only, or mainly, by the power of the light source. —ARG

New TV color projector throws giant pictures; but it stands just 5 ft high. Expected cost is about $16,000.

DEVELOPMENTS TO WATCH...

world-wide

New studies of friction in non-metals . . .

. . . reported by British researchers to the SAE, point up the difference between rolling and sliding types.

Rolling friction, says Dr F P Bowden of Cambridge University, "is found to be due to internal friction or hysteresis losses . . . and not to surface interaction."

Sliding friction of solids on such soft materials as well-lubricated rubber is also traceable primarily to elastic hysteresis loss within the rubber itself, Bowden says.

When graphite or carbon is involved, though, sliding friction takes on a different aspect. With graphite sliding on itself or on copper or silver, Bowden says, the friction falls steadily as the temperature is raised. With graphite on many other metals, however, the friction rises to a high value at about 1830 F. Formation of metallic carbides at the interface seems to be responsible.

Experiments are now being conducted with carbides of boron, titanium, and tungsten. Preliminary reports indicate that friction "first falls as the temperature is increased, and then, at about 1830 F, rises steeply to a high value." The reason is not yet clear.

Acid resistance of stainless steels can be increased . . .

. . . by adding small percentages of the platinum metals, says Johnson, Matthey & Co (London), quoting recent USSR studies of passivation mechanisms and techniques.

In tests of 18-9 nickel stainless to which platinum and palladium had been added in percentages ranging from 0.1 to 0.9, they found the corrosion rate in sulfuric acid drastically reduced, particularly in the alloy containing 0.9% Pd. Even more remarkable were the improvements in corrosion resistance when the minor additions were made to high-chromium alloys such as a 26% Cr–0.5% Ni steel.

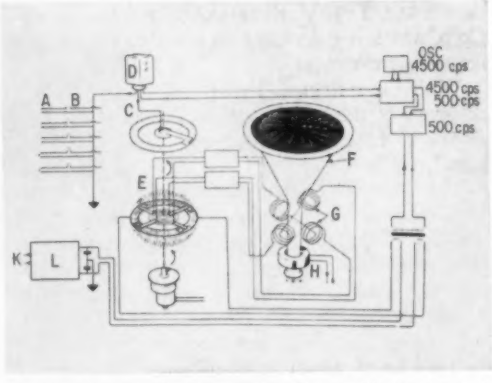
As J-M itself points out, there are many critical factors in these passivation techniques and "the practicability of noble metal additions must be regarded with some reserve until more extensive trials have been made." It is also true that economic considerations will by no means always allow even a 0.1% addition of platinum to stainless steel. This is particularly true since rather good results (between what 0.1% Pd and 0.1% Pt can do at acid concentrations above 30%, and only slightly poorer than 0.1% Pd at lower concentrations) can be obtained with 1.2% Cu. Nevertheless, the noble metal alloys might well prove practical for comparatively small components where maximum acid resistance is required and more extensive testing is considered to be justified.

A hundred measurements can be taken almost simultaneously . . .

. . . with the system outlined here, its French developer claims. Originally designed by Compagnie Francaise Thomson-Houston, 173 Boulevard Haussman, Paris, for measuring the temperature of uranium rods in a nuclear reactor, it's now being adapted for industrial use.

Heart of the system is a series of thermocouples (almost any number can be used), indicated here at the left, with hot junctions at *A* and cold junctions at *B*. These are scanned every 2 sec by the rotary collector-selector *C*. Other elements include a transistorized chopper *D*, a sine-cosine potentiometer *E* which has its scanner synchronized with that of the collector, and a rotating-beam planned-position indicator oscilloscope *F*. *G* and *H* are deflection and focusing coils for the oscilloscope. *K* is the power input and *L* a voltage rectifier.

This system, the French say, can be adapted for use under a wide range of conditions in a number of different industries. —ARG



Temperature-monitoring system is surprisingly simple in outline, can be arranged in a variety of ways to take simultaneous measurements of almost any physical phenomenon that can be converted into electrical values—pressures, speeds, outputs, and the like.

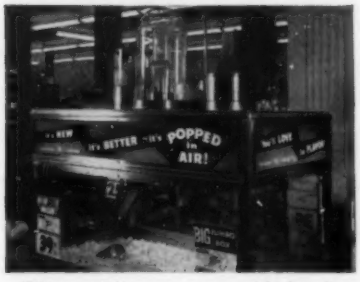
THIS IS GLASS

A BULLETIN OF PRACTICAL NEW IDEAS FROM CORNING

POPPER THAT'S A STOPPER

It has been pointed out to us that every day the world survives, fewer are the chances that anything is the most, the biggest, the only, or the first.

But this corn popper *is a first*—to the best of our knowledge.



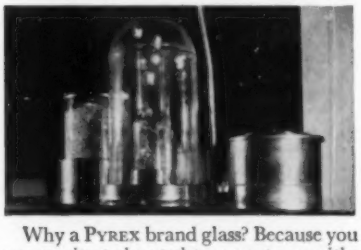
This machine pops corn with *hot* air—and all the action takes place *before your eyes*.

But that's putting the cart before the horse, because it was quite a number of moons ago when the designers at Electri-Cooker Division of General Foods were at the idea-developing stage.

They wanted a *new* way of popping corn. And they wanted to boost sales by having all the popping parts *visible*.

So, they developed a way of turning kernels into a fluffy delight with a *blast* of hot (about 200° F.) air. Then they turned to Corning.

And Corning in turn came up with a number of key components made from a PYREX brand glass. Included are a 17-inch display dome, 13-inch lamp chimney, and an 8-inch chamber for storing unpopped corn.



Why a PYREX brand glass? Because you can use it at elevated temperatures without worrying about thermal shock. (For example, PYREX brand glass No. 7740 has a linear coefficient of expansion of 32.5×10^{-7} in./in. between 0° and 300° C.)

Also, you can see through glass (an obvious but still extremely useful feature).

And glass is so easy to keep clean, there's no place for dirt to lodge in its *smooth* surface. Glass No. 7740 also is resistant to the attacks of most acids and alkalies and stands up well under distilled water.

You can find machines dispensing corn popped by hot air at Woolworth's, Grant's, Kresge's, McCrory's, Newberry's and Sears Roebuck & Company. You can find *glass* answers to one of your materials or component problems by coming to Corning.

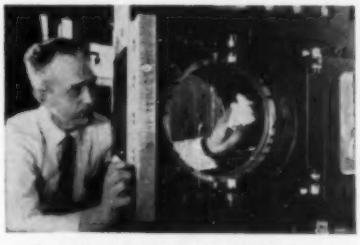
You can get a head start by perusing "This Is Glass," a 64-page, well-illustrated primer. And/or ask for Bulletin B-83, a detailing of mechanical, thermal, electrical, and chemical properties for three of Corning's most popular types of glass. Use the coupon.

PURITY—KEY TO FUSED SILICA'S VERSATILITY

What material would you pick if you had the problem of accurate spectrum *transmission*, growing *high-purity* crystals, or building a component that would *not* darken under radiation?

The answer: Corning's 100% Fused Silica, an extremely versatile material that will handle these, as well as many other, specialized tasks. And the key to this material's versatility is its *extreme* purity.

Capacity to stand up to high temperatures, coupled with optical properties that yield excellent schlieren or shadowgraph quality, makes fused silica a natural for installation in wind tunnels for designing supersonic aircraft and missiles.



Optical purity and a high softening point (1585° C.) make Corning's 100% Fused Silica useful in wind tunnel windows.

Fused Silica also is used in ultrasonic delay lines, being well suited for handling delays ranging from 10 to 16,000 microseconds. More: You'll find this material possessed of high electrical breakdown resistance, low dielectric loss, and low expansion. And it is permeable to helium.

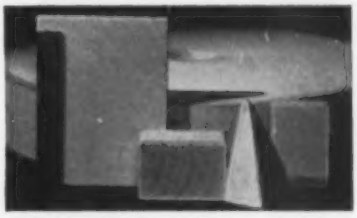
Uses (other than ultrasonic delay lines and windows for wind tunnels) include the following: windows for high-temperature applications, windows for hot cells, and the optical components for ultraviolet instruments.

All the facts are now available in spec sheet form. Check the coupon.

NEW—CELLULAR CERAMICS

Now, for the first time, from Corning's Cercor process, you can get thin-walled cellular ceramics.

These cellular ceramics are lightweight, resist oxidation, and have an extremely high surface area. Here is a sampling of Cercor products.



The material used to make these objects has 1500 square feet of surface area per cubic foot. Individual wall thickness averages only 0.005 inch; weight is only 30 pounds per cubic foot.

This material can withstand temperatures up to 1800° F. with virtually no thermal expansion, and can be operated continuously at 1290° F. At either temperature you don't have to worry about thermal shock or oxidation.

To provide additional strength, a ceramic coating can be bonded to the exterior of most cellular forms.

The composition of the Cercor materials may be changed to provide desired physical and chemical properties, and further development is expected to result in a broadening of potential configurations and product shapes.

Suggested uses so far include structures for use in gaseous heat exchangers, catalyst supports, burner plates, column packing, and acoustical filtering, flow control, insulation, and structural materials in high-temperature applications.

Inquiries invited. And/or ask for a just published bulletin detailing all pertinent data and characteristics.

CORNING MEANS RESEARCH IN GLASS

CORNING GLASS WORKS 51 Crystal Street, Corning, N.Y.

Please send me: ☐ "This Is Glass"; ☐ Bulletin B-83; ☐ Fused Silica; ☐ CERCOR

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Company_____

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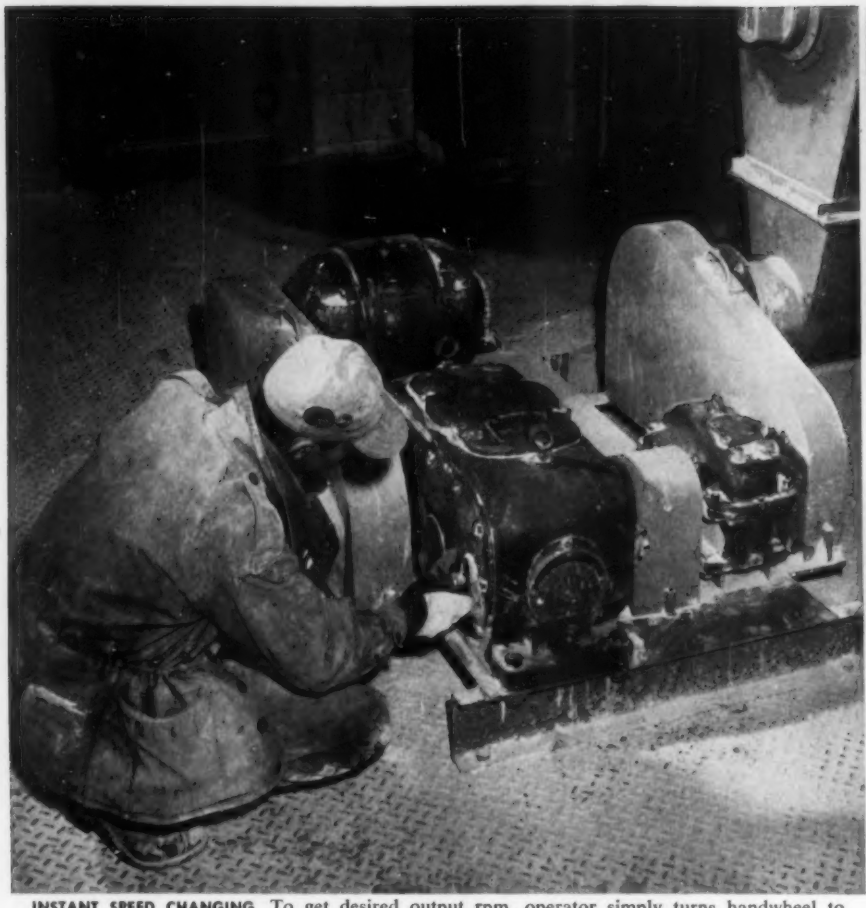

INSTANT SPEED CHANGING. To get desired output rpm, operator simply turns handwheel to desired position on easy-to-read dial. P.I.V. responds instantly, accurately. Drives are also available with automatic, electric, pneumatic or hydraulic controls.

SELF TOOTH-FORMING CHAIN consists of a series of steel laminations, serving as teeth, which are free to move from side to side, either singly or collectively.

RADIALLY GROOVED WHEELS have teeth cut at constant depth but of increasing width toward wheel periphery. Beveled sides of teeth provide gripping surfaces for chain.

Slipless transmission - - stepless selection

That's because LINK-BELT P.I.V. uses self-tooth-forming chain

LINK-BELT P.I.V.—unlike other variable speed drives—incorporates an exclusive metal, self-tooth-forming chain to give you instant, positive speed variation, regardless of load. This unique drive permits infinitely variable speed changes without loss of accuracy or interruption of operations. That's why P.I.V. is all industry's choice for jobs requiring stepless, slipless power transmission.

Changing speed is simple too. A turn of the control screw simultaneously varies the effective diameters of two sets of conically shaped wheels—closing one set, spreading the other. At the same time, the self tooth-forming chain automatically adjusts to provide desired ratio between the input and output shafts.

Link-Belt P.I.V. drives are fully enclosed for trouble-free operation. They're splash-lubricated for long life—unaffected by atmospheric conditions. Choose from 8 sizes in 16 standard types, with the aid of Book 2274. Call your nearby Link-Belt office or authorized stock-carrying distributor for complete information. 14,314

LINK-BELT P.I.V. VARIABLE SPEED DRIVE

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DEVELOPMENTS TO WATCH...

Washington

The fight over our progress in space-missile field . . .

will dominate much of the Washington scene this year and next. The issue is where we are in relationship to the Russians, and whether or not Eisenhower and his top men are exerting their leadership to keep us where we ought to be.

The problem is confused by the difficulty of learning and evaluating the technical progress we've made in a variety of interrelated fields—and the difficulty of knowing just how far the Russians have advanced in the same fields.

Since there are few clear cut answers, when the politicians—and the military—take to the stump, virtually any point can be backed up with convincing—and confusing—arguments.

To help clarify the air, here—boiled down to their essentials—are the Eisenhower and Democratic positions, with the verbiage and supporting evidence chopped away:

• **General space exploration**—The administration says, overall, we're up with the Russians, not really lagging behind, except in a few areas.

Democrats say, "Maybe so, but the areas where we are behind are the really critical areas."

The consensus is that the US and Soviets are running nip and tuck on satellite launchings and moonshoots—notwithstanding the success of the Russian Lunik.

Watch for Congress to vote more money for overall space projects.

• **On propulsion systems**—the administration admits we may not have as powerful an engine right now as the Russians have, but we've got engines powerful enough to do anything they can do. With our ICBMs, we can put a nuclear warhead on any city in Russia.

Democrats say, "We are probably 3-4 years behind them now, and we aren't catching up at all."

A single US engine capable of producing a million pounds of thrust is 4-5 years away. Money can't speed this development up much, it is a matter of time.

The Russians, on the other hand, have more thrust now and are probably not far off from getting million pound thrust engines.

The US and Soviets are rated about even in liquid propellant progress. The US leads in solid fuels. The Russians lead in harnessing atom power to propel aircraft and possibly for space exploration. Watch for Congress to stress propulsion in its rush to pump more money into the space program.

• **With guidance systems**—the administration claims a definite superiority.

The Democrats say, "Maybe we are ahead here, but Russian successes in space mean for sure that they are not significantly behind us." Reports on Soviet ICBM accuracy indicate good guidance systems, too.

The Democrats will talk about Russian accuracy, but likely won't demand that more money be put into this area.

• **ICBM missiles**—The administration says our success in speeding up Atlas and Titan programs puts us up with the Russians, or close enough.

The Democrats admit a "maybe." But, they don't want any coasting on the program.

Observers give the Soviets an edge, but not a significant one. It is easier to speed up these programs than space exploration. There is a good chance Congress may increase money for the ICBM programs.

• **Atomic airplanes**—the administration claims we are working on an orderly program that's going ahead just enough.

The Democrats want the pace stepped up sharply. They claim this is another area where we have failed again to push hard enough. Reportedly Russia's closer to actually flying atom powered craft.

Watch for Congress to increase spending in this field.

• **Missile carrying submarines**—the administration stands by its present program of up to nine of the Polaris missile carrying jobs and a half dozen regular nuclear-powered subs a year.

The Democrats want more submarine construction. They point to the better than 5-1 edge the Soviets have in sheer numbers of subs over the US.

Watch for the administration to hold the line on this issue.

Spinning atoms for process control

A technique with a formidable name (but, fortunately, a convenient abbreviation) may soon provide a new route to flow-rate measurement and closed-loop process control. It's already at work in research on electrical conduction in metals, determination of moisture content in granular materials, and analysis of many organic materials (including the organo-metallics now being studied for use in lubricants, antiknock compounds, and high-energy fuels).

Its name: Nuclear Magnetic Resonance spectroscopy (NMR, for short). Its advantages: ability to analyze for many elements (hydrogen, carbon, and silicon, for instance) which do not lend themselves to ordinary spectroscopic techniques; and to do the job at high speed (often in half a minute) to an accuracy of 0.1%.

Basis for NMR is the characteristic absorption of radio-frequency energy by certain elements when they are placed in a magnetic field. (By contrast, X-ray fluorescence analysis depends on the relative position of electrons around the atomic nucleus; and X-ray diffraction, on the arrangement of atoms in a molecule.)

According to present theories, the characteristic energy absorption that forms the basis for NMR analysis stems from the fact that some atomic nuclei have a definite angular moment or spin as well as a magnetic moment. They can be considered as tiny bar magnets, spinning about their own axes. When placed in a magnetic field, they behave much like baby gyroscopes, precessing around the direction of the field. Under normal conditions their position cannot be changed. But if a second magnetic field is applied at right angles to the first, these spinning protons can be tipped over—and the wavelength at which the protons tip becomes tip-off to the atom's identity.

Not only protons but also the electrons of some elements can be made to spin—and tip over—in this way. It just takes a higher frequency (9000 to 25,000 mc as compared to 1 to 60 mc). This electron technique is known as Electron Paramagnetic Resonance spectroscopy (EPR), and is especially useful for such jobs as study of electrical conduction in metals, analysis of radiation damage, and studies of polymers and semiconductors.

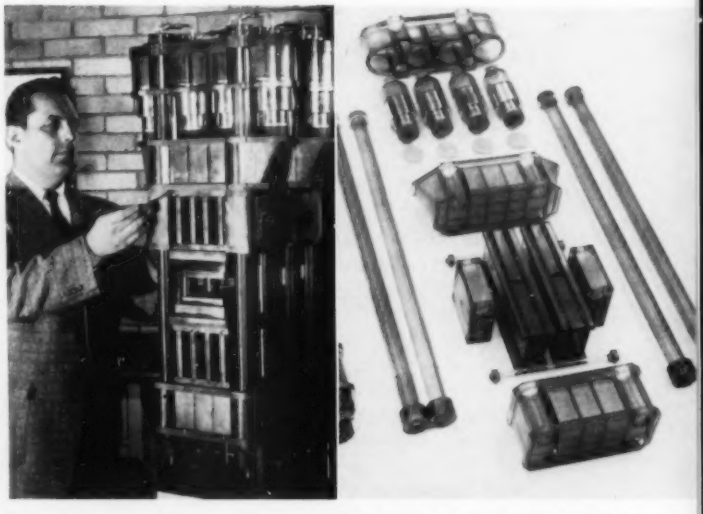
Although the commercial potential of NMR and EPR for process control and the like has barely been scratched, laboratory instruments are commercially available in several sizes and types, and much information on the technique is available from equipment suppliers. One, Varian Associates, even runs an annual NMR-EPR workshop for those interested in applying the techniques; another supplier, Schlumberger Well Surveying Corp, builds a special moisture analyzer as well as equipment for general laboratory use and others offer special control units. —ARG

Taking a look at thermal stress

Thermal stresses can be visualized by photoelastic techniques, just as mechanical stresses are, NYU College of Engineering researchers have found. They're using this method to study heavy press design and learn more about thermal stress distribution in airframe sections; and they've come up with a surprising result: Predictions of thermal stress based on present theories are considerably higher than the actual observed stresses—sometimes by as much as 30%. Furthermore, the discrepancy increases as the Biot number (an index based on flange thickness and heat-transfer coefficient as related to thermal conductivity) increases.

For the thermal stress models, NYU engineers are using epoxy casting resins. Dry ice, applied at predetermined time intervals, produces thermal shock, and temperature is measured at the same time the fringe pattern is photographed so that an exact correlation can be made. The photographs show the heavy press model and the components used in photo-thermoelastic studies.

Note: For a major report on photoelastic stress analysis, see *PE*—Sep '56, p 167.



Heavy press model, on 1/24 scale, aids thermal stress studies. Exploded view at right shows several of the transparent epoxy-resin components used for photo-thermoelastic measurements at NYU.

WHAT'S HAPPENING IN... Materials

Guides to this Plastics Age

Each advance in technology seems to bring with it a whole new lexicon of terms. But, it takes a lot longer for new terms to get into standard dictionaries than it does for new materials to reach commercial application. That's why we've been preparing our own glossary of plastics terms (*PE*—Apr 21 '58, p 17 and May 5 '58, p 16), and why a good many companies in the field are offering handy guides and lexicons.

From Phillips Chemical Co, Bartlesville, Okla, for instance, comes a 32-page *Glossary of Plastics Terms* that covers standard resins and molding techniques, also features a special section defining terms specifically related to linear polyethylene.

More technical in nature, less elaborate, but equally useful, is a "Research Note" on urethanes prepared by National Aniline Div (Dept NA46), Allied Chemical Corp, 40 Rector St, New York 6. It defines half a dozen terms ("acid number", "hydroxyl number", etc.) used in formulating foams, and tells how they are calculated. Both publications free on request.

New names for rubber

The familiar synthetic rubbers, many of which have already gone through a name-change or two, are changing names again, as the ASTM's suggested nomenclature, based on chemical composition, gains acceptance. Here is a brief conversion chart:

SBR: Styrene-butadiene rubber. This is the familiar *GR-S*, once known as *Buna-S*

NBR: Nitrile-butadiene rubber, formerly *GR-N* and *Buna-N*

CR: Chloroprene rubber, better known as *neoprene*, and once labeled *GR-A*

IIR: Isobutylene-isoprene rubber, commonly called *butyl*; once *GR-I*

The ASTM system, outlined in Designation D 1418, also makes provision for a number of new types, including synthetic "natural" rubber (IR), and natural rubber itself (NR).

Also worth noting: the latest revision of the SAE-ASTM tentative specification for elastomer compounds for automotive applications (D735).

briefs . . .

Foam pipe for ducting, in which flexible urethane foam serves as the structural element as well as the insulation, has been developed by Standard Plastics Inc. It's made by casting the foam to shape, using coiled spring wire as reinforcement, aluminum foil as a liner, and polyethylene film on the outside to protect against moisture.

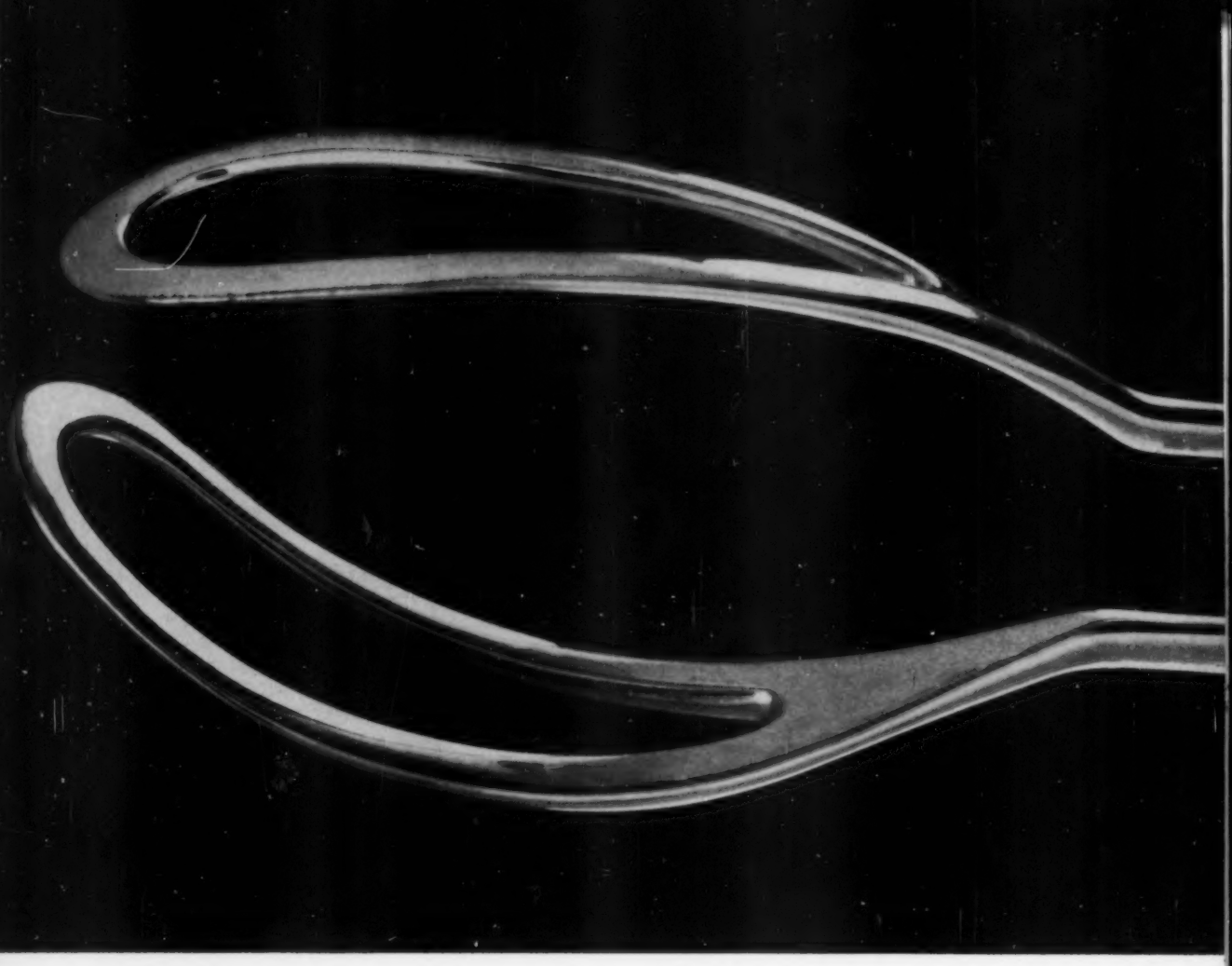
Ceramic paints are being eyed by the Army as a means for protecting rocket launchers, rifles, and other ordnance equipment. In preliminary tests at Rock Island Arsenal, the Army reports, "ceramic-type coatings remained nearly intact on aluminum panels heated almost to the melting point." Also worth further investigation: Teflon (TFPE fluorocarbon resin) and zinc dibutyl-titanate compositions. A report on the first steps in this investigation is available from OTS, Dept of Commerce, Washington 25, DC (PB 131543, 19 pages, 75¢).

Latest Stockpile Report shows basic objectives met for all but a few materials and components—certain grades of asbestos and mica, fluorspar, silicon carbide, bauxite and manganese ore; two metals, palladium and selenium; and small diamond dies and jeweled bearings. For most of the rest of the 75 materials listed, the bins are full to overflowing.

Zirconium-copper, for commutator bars and other applications requiring strength and fatigue resistance at temperatures to 750 F, is now being produced commercially by Nippert Electric Products Co, Columbus 23, Ohio. This is an alloy developed by Battelle Memorial Institute for the special application noted, but Nippert engineers believe it may have a number of other uses. As they point out, it has an electrical conductivity of 90 to 96% (IACS), can stand short term exposure to temperatures above 900 F, and has an unusually high notched rupture strength. —ARG

Heading for tough service

New tester, built at Battelle Memorial Institute, puts gear and bearing materials and lubricants through their paces under conditions of high stress at elevated temperature. Incandescent quartz elements provide heat—to 1000 F; and the system is so arranged that the two disks, rotating in contact on separate shafts, at speeds to 15,000 rpm, can simulate the action of either gears or rolling bearings.



Corrosion Resistance It is an immutable law of Nature that all things seek their most stable state. Nitroglycerine craves opportunity to explode back into passive water and gas vapor. Radium glows silently as it decays into lead. Metals yearn to return to their oxides.

Corrosion is simply the return of a metal to its most stable form. It's an electrochemical process that is generally speeded up by the presence of salts, acids and moisture—in fact, at humidities below 50% there is virtually no atmospheric corrosion of steel. There are six common ways to minimize corrosion: select the right steel, apply protective coatings, install cathodic protection devices, set up periodic cleaning procedures, control the corrosive environment, and use *design* techniques which reduce the likelihood of corrosion.

We have a record of one case where a manufacturer installed expensive piping to transport gaseous chemicals—overlooking the fact that ordinary carbon steel pipe would do the job just as well *if it were insulated* to prevent condensation of the chemicals inside the pipe. Sometimes a vessel is designed with great care so that it will hold a corrosive liquid, only to have the vessel attacked from the *outside* because the support brackets harbored pockets of moisture. And there are cases on record of stress corrosion failure because it was not recognized that stress relieving was necessary after cold working the metal.

Actual service records or true-to-life corrosion tests are the safest ways to judge a grade of steel, and you can often avoid the expense and time-consuming nature of making your own tests if you check first with United States Steel.

A corrosion problem that is new to you may be familiar to us, and we may be able to supply you with information that will solve your particular problem promptly.

Another good reason for coming to United States Steel is this: no matter what kind of steel you need, you're sure to find it among the vast range of USS Steels for Design. The final selection, of course, should be made by a skilled metallurgist. Our technical staff is always available to consult with you about your problems. United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

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STEELS FOR DESIGN

Stainless Steel obstetrical forceps

Lower Left—Problem: The City of Pittsburgh wanted a trouble-free hull on their new, all-steel fireboat. Solution: Paasch Marine Service built the hull with ¼" USS COR-TEN High-Strength Low-Alloy Steel. Payoff: A light, strong hull that has four to six times the atmospheric corrosion resistance of carbon steel plus superior paint adherence.

Lower Middle—Problem: Combat corrosion in the new Carquinez Strait Bridge by designing smooth, welded members eliminating details vulnerable to corrosion. Solution: USS "T-1" Constructional Alloy Steel and USS TRI-TEN High-Strength Low-Alloy Steel, both weldable and both having superior resistance to atmospheric corrosion. Payoff: The smooth, welded framework will assure much lower maintenance costs than the annual $70,000 needed to paint and maintain the old, riveted bridge. (And a bonus advantage: "T-1" Steel's high yield strength permitted strong, lightweight design, saving $800,000 in over-all cost.)

Lower Right—Problem: Design a preheating unit for a textile plant to handle hot water with a highly corrosive caustic soda content. Solution: 19,000 lineal feet of Type 304 Stainless Steel tubing inside the Stainless shells. Payoff: Ludell Manufacturing Company predicts that the unit will last indefinitely.

How can your customers Know ...unless your product can COUNT?

How can they know that they're getting out of your product all the performance you build into it — unless you *also* build into it a Veeder-Root Counter as a standard part? Then they have a running record of performance that shows them where they stand every minute of the working day . . . and a record that proves your product's guarantee. What's more, it gives you a new plus in selling.

How to build it in? Count on us to show you. Write, or phone JAckson 7-7201.

You always "Know the score" when you count on Veeder-Root!

Vary-Tally Multiple Unit Hand-operated Counter. Easy keyboard action. All units on same row reset instantly to zero with one turn of knob. Supplied in practically any number of units, in any arrangement.

New High-Speed Predetermining Counter, Series 1522, features instant lever reset plus quick and easy setting of predetermined number. Speeds up to 6,000 rpm. Also supplied without predetermining feature.

New "Count-Pak", a complete electronic counting package for use where high speed, long life and instant reset are required. Rated at 20,000 counts per minute (with added decade speeds run up to 200,000 cpm). *Completely transistorized.* Photohead adaptable to any job. Several other "Count-Paks" available.

Everyone can Count on **Veeder-Root Inc.**

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Product Engineering

HORIZONS

January 26, 1959

EDUCATION with EXCITEMENT

Sputnik I set off much more than an accelerated US defense effort; it also has caused much more controversy about our educational methods than any other factor. The advocates of science at once got in telling licks, now being countered by the advocates of the humanities. The proponents of selective education had their say; now being opposed by the proponents of general education. The Russian and American systems have been compared endlessly. And, as usual, there have been many more words and thoughts than actions.

In our commuter town, class periods in high school were lengthened from 50 to 60 minutes. An effort to start classes in Russian, rejected last year, was granted this fall on an after-hours, no-credit, no-homework basis. Even so, 75 children signed up; about 60 have stuck with it thus far.

Sporadic efforts are being made to de-emphasize the superficial and re-emphasize the essential. But opinion on essentiality is worse than divided; it is confused and too often based on tax bills, personal offspring, or prejudice rather than the "greatest good for the greatest number."

There is little question, however, that some serious flaws have been revealed in the system that makes it so easy on Johnny that he can neither read nor count, that provides him with the social graces but no ability to earn a living, that makes a college diploma representative not of education achievement but of social status.

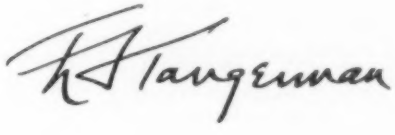
Our hope can be that this period of examination will result in a more realistic look at the whole problem. There is no question but that education should be available to all, and not on a double-session basis either. Likewise no question that the exceptional child should have the opportunity to move ahead of a mythical but nonexistent "average" which too often is a pace more nearly that of the slowest group or the slowest individual.

This requires some miraculous way to get around parental pride and conniving. Every parent assumes his child is the best in the class—or some skullduggery is afoot. We have competitive grading and placing, plus a peculiar kind of "democracy" which provides that every child shall be given every opportunity, whether he is equal to it or not. (Currently, every child is to be a scientist, and every child who takes a watch apart has demonstrated ability as an engineer.)

The necessity is to re-excite the student, to make him understand the value of what he's getting, to make him work for it. In this connection, it is interesting to note that the USSR, which had a purely competitive system (discounting politics), is now introducing a 2-year or 3-year interim of work after eight years of schooling—a period during which the student can orient himself with regular wage-earning. A similar policy here would help many students to appreciate a college education and provide them with the perspective and direction necessary to get major effectiveness from it.

The inspired and effective teacher must be encouraged by adequate incentives, just as it's done in industry, not held to a low mass-salary scale that is excused on the basis of "democracy" and the security of tenure. (The USSR requires each teacher to be re-examined each five years, and pays successful ones at rates equal to those in industry.) No teacher should have to choose between teaching and driving a cab.

Such teachers can reawaken the student to the value of education as such. With proper support of the program from parents, we may get from our secondary schools graduates of college calibre, and from our colleges graduates fitted to do a major job in a truly American culture —be it in business and industry, or in academic circles.



(Advertisement)

Special Reports On Finishing Non-Ferrous Metals

NUMBER II—Paint Base, Corrosion-Resistant Finishing with Iridite

WHAT IS IRIDITE®

Briefly, Iridite is the tradename for a specialized line of chromate conversion finishes. They are generally applied by dip, some by brush or spray, at or near room temperature, with automatic equipment or manual finishing facilities. During application, a chemical reaction occurs that produces a thin (.00002" max.) gel-like, complex chromate film of a non-porous nature on the surface of the metal. This film is an integral part of the metal itself, thus cannot flake, chip or peel. No special equipment, exhaust systems or specially trained personnel are required.

Chromate conversion coatings are well known and accepted throughout industry as an economical means of providing corrosion protection, a good paint base and decorative finishes for non-ferrous metals. However, continued developments have been so rapid and widespread that many manufacturers may not be completely aware of the breadth of application of this type of finish. Hence, this digest of current information; to bring you up to date on the many ways in which you can obtain proper surface preparation for painting and increase product durability with a single multi-purpose chemical pretreatment. Report I on decorative, corrosion-resistant finishes and Report III on chemically polished, corrosion-resistant finishes are available on request.

First, it is an accepted fact that metal surfaces should be prepared before painting to make possible an efficient paint system. Naturally, this preparation should provide for good initial paint adhesion. Chemical treatments have proved extremely effective in this respect, particularly those of a neutral or preferably acid nature. Further, to be most efficient, chemical treatments should provide a non-porous barrier to maintain adhesion by sealing the metal from the paint and moisture. They should also provide a self-healing film which prevents lateral corrosion in the event that bare metal is exposed through scratching.

The Iridite chromate conversion coatings meet all these requirements. Iridite is a chemical conversion treatment for surface preparation. It provides initial paint bonding by molecular adhesion. It is acid in nature and produces a film that is gel-like and non-porous in structure. Thus, the Iridite film effectively seals the metal from the paint and from moisture penetration. Because the film contains certain relatively soluble constituents, it will protect areas scratched through to bare metal and prevent lateral corrosion. This is accomplished by a gradual leaching of these constituents into the damaged area.

Further, because of its gel-like, non-crystalline nature, the Iridite film will not affect the appearance or texture of the paint film, nor will it dust or powder to mar the painted surface. Because the film is non-porous, paint coverage is increased, thus substantial savings in paint costs will be realized. In addition, treated parts may be stored for long periods of time prior to painting without the risk of entrapped moisture causing blistering when painting.

Iridite chromate conversion coatings are widely used with equal ease and success under both baked and air-dried paint systems. While the actual adherence properties of the Iridite film do not increase appreciably with its thickness, corrosion protection does. The protection of the Iridite film is proportionate to its thickness and should be taken into consideration when selecting the Iridite to meet your needs. However, it is sometimes necessary to sacrifice maximum corrosion protection for appearance when a finished part is to be only partially painted. For example, it may be desirable to use a thin, clear, bright Iridite film if the unpainted areas must present a chrome-like appearance. A typical case is that of instrument housings on which the exterior is painted and the inside left unpainted.

On the other hand, if all surfaces of the product are to be painted and maximum corrosion protection is required, the heavier and most protective Iridite films should be used. For example, all surfaces of zinc die cast fruit juicers are finished with a highly protective Iridite film prior to painting to provide maximum resistance to the corrosive action of fruit juices.

Iridite finishes are now available for all commercial forms of the more commonly used non-ferrous metals, including zinc, cadmium, aluminum, magnesium, silver, copper, brass and bronze. In addition to providing an excellent base for paint, the Iridite films also have high decorative value when used as final finishes in themselves.

These films can produce a wide variety of pleasing appearances including clear bright, iridescent yellow, bronze, olive drab and brown. In addition, many films can be modified by bleaching or by dyeing. Among the dye colors available are various shades of red, yellow, green, blue or black.

In planning or designing, you should consider the many other characteristics of Iridite finishes which may enter into the specific problem. In addition to their functions as protective and decorative finishes, and as bases for organic finishes and bonding compounds, Iridites have low electrical resistance. Some can be soldered and welded. The film does not affect the dimensional stability of close tolerance parts.

Iridites are widely approved under both Armed Services and industrial specifications because of performance, low cost and savings of materials and equipment.

You can see then, that with the many factors to be considered, selection of the Iridite best suited to your product requires the services of a specialist. That's why Allied maintains a staff of competent Field Engineers—to help you select the Iridite to make your installation most efficient in improving the quality of your product. You'll find your Allied Field Engineer listed under "Plating Supplies" in your classified telephone book. Or, write direct and tell us your problem. Complete literature and data, as well as sample part processing, is available. Allied Research Products, Inc., 4004-06 East Monument Street, Baltimore 5, Maryland.

Purdue Sets Up R & D Curriculum as Prep for Graduate School

LAFAYETTE, IND.—Approximately 10% of the sophomore Electrical Engineering class at Purdue Univ. is enrolled in a special R&D curriculum, the first of its kind in the US, designed specifically to better prepare the student for graduate work in electrical engineering rather than outfit him for an immediate postgraduate job in industry.

Conducted under supervision of the EE Dept's R & D Curriculum Development Committee, which gave the matter studied consideration for 7 months, the experimental program will get into high gear during junior and senior years. Emphasis is on basic concepts that "supply student with an appreciation of the interrelationships between different fields of knowledge and technologies."

Program is being supervised by Prof. T. F. Jones, Electrical Engineering Dept head, and Prof F. V. Schultz, committee chairman. Still in the experimental stage, according to a dept spokesman, the R & D Division has not yet been given official university approval, but Prof Jones has been granted a trial-and-error go sign.

The committee doesn't deny that the program is created for the "superior" student, feeling that above-average undergrads tend to lag when tied to the average students. Given higher standards to meet, he will be better prepared for the more demanding graduate schools. By the same token, average students will be freed from the shadow of the superior individual.

Aimed at the graduate level, the course will not include the terminal type courses, and will be more theoretical. For instance, a 5-credit course in Energy Conversion will be offered, and here's how Jones' committee says it will handle it: "All the externals of dc machines from the black-box approach or systems concept, will have been mentioned in Analysis of Linear Systems. In the new course we will analyze the dc machine from the systems point of view, also, but here we will be concerned with the effect of various machine parameters on the time constant, figure of merit and other externals of the machine performance. The same will be done with the ac machine. We will consider the traditional ac machine, but devices such as ac adjustable-speed drives, that illustrate many basic principles, synchros, 2-phase motors, tachometers, aircraft type alternators, etc., will receive somewhat more detailed attention.

"We do not intend merely to substitute a few new devices into the traditional framework of an ac machine course, rather we will attempt to show how basic principles apply to all devices, and to force the student to develop new machines himself. An example might be to design a linear induction motor for an aircraft catapult or to design a pump for liquid metals in a nuclear reactor that operates on the principles of an electric motor.

"Next, a comparison of electric components with other types of transducers is in order. Perhaps a closed system such as a missile will be hypothesized. The student will be requested to determine whether an electric system, a hydraulic system, a pneumatic system, a mixture of these, or something else entirely, should be used to power the system.

"This will lead into transducers other than electrical-to-mechanical and vice versa. Such items as thermal-to-electrical transducers, the solar battery, and the nuclear battery should be discussed. Certainly, nuclear reactors of all types would be considered."

Mathematics and physics will receive major attention but in such a way that the student will be firmly based, the studies being valuable to him no matter what field he chooses in graduate school. Mathematics will be offered in the form of advanced calculus, complex variables, probabilities and statistics, narrow applicability, and vector analysis. Physics will be slanted to mechanics, thermodynamics, kinetic theory and statistical mechanics.

Other features of the program include: (a) bringing desirable course elements into the regular courses; (b) selection of students based on freshman year scholastic record; (c) written, comprehensive final exams as well as frequent oral exams; (d) at the end of senior year students will be examined by a visiting Board of Examiners (outstanding engineers from other parts of country); (e) summer work in industrial installations in positions of an R & D nature, rather than routine testing or production; (f) max of 4 courses (including 1 course in humanities) for any R & D student during last 7 semesters, and no technical electives; (g) lab work to emphasize that efforts are aimed at creating a device, not a theory, and permit student to participate in design; (h) grading not to be on "curve"—"C" marks could transfer a student back to regular courses.

Faculty participation will be revolving in nature. Those in the department with a particular interest in the program, and willing to assume the additional teaching burden, will comprise bulk of the staff.

Germanium Locomotive Power Rectifier Passes 3-year Test

LONDON—The first locomotive to use a germanium power rectifier to supply the motive power has just completed 3 years of successful commercial testing, according to its owners, British Railways. The unit was designed for 750 kw at 1500 v dc with a peak current during acceleration of 1000 amp.

The company reports only one major failure during the 3-year test, and this was caused by poor ventilation when on an unusually hot day an attempt was made to pull a second train. Failure occurred at 25% voltage. Seven of the 12 fuses had blown while 10 of the 12 strings of cells had failed—some of the cells were blown apart.

As a corrective, a thermostat was added to the rectifier cooling air duct to prevent operation if the air temperature exceeded 105 F. Ventilation was also improved.

At present, a silicon rectifier has been used in one motor coach since July, 1958, and, according to British Railways, has been highly satisfactory. The company says that the successful tests show that both germanium and silicon rectifiers have a place in ac traction equipment.

Agree Reliability Wedded to Design Stage

PHILADELPHIA—Reliability starts with the design—this was the title of one paper at the Fifth National Symposium on Reliability and Quality Control, but the same point was made in a number of others.

Dr. Irvin Whiteman of the General Analyses Corp said that rather than wait for the unit to be built and then set up the experiment to test it, the designer at an early stage may be in a position to make some preliminary estimates as to what performance will be—both of the units and the final assembly.

O. Golubjatnikov, of General Electric's Heavy Military Electronics Dept, agreed that equipment reliability is determined in the design stage: "It cannot be made reliable as an afterthought. And no amount of testing, design reviewing, or reliability predicting will make the equipment reliable, unless it is designed so in the first place. Of equal importance is the proper selection of components."

Reliability of transistorized circuits has been upgraded by Philco Corp according to R. J. Segal, who discussed company's TRANSAC S-2,000 large-scale data-processing system. He said the S-2000 switching circuits were specifically designed for transistors with uniform characteristics maintained by controlled production techniques, and that the low failure rate and stability of the transistor resulted in a shift of emphasis from component reliability to circuit reliability. Although sufficient data is not yet available on the testing and debugging of the S-2000, Philco claims its reliability is "significantly better than that of any currently available vacuum tube systems."

G. N. Beaton, head of the Systems Reliability Section of the Systems Engineering Dept, Hughes Aircraft Co, warned that a new challenge is facing the reliability man—that the military services and his own management are looking to him for solutions which may involve saving millions of dollars for the government, and enhancing the success of his own organization.

American reliability programs and interest in product reliability have progressed more than in Britain, Kenneth Hopkinson of the Royal Radar Establishment, British Ministry of Supply, told PRODUCT ENGINEERING. "We would be lucky to get 50 at a comparable meeting in England. We just can't get people interested in the subject, although I have been in it for over 10 years. My group did a great deal of work on vacuum tube reliability. And now that we have completed the job, tubes are on their way out."

Good Ideas Plus Good Management-Profits

NEW YORK—The most profitable ideas seldom sound logical at first, but not all illogical sounding ideas are unprofitable. Choosing between the two is the crucial problem for the manager of an engineering department, Lloyd A. Hatch, vice-president, Research and Products Div., Minnesota Mining and Manufacturing Co, told the American Management Association here.

To manage an engineering department that produces profitable ideas, the director must first have a clear statement from management outlining the company's growth objectives, production facilities available for new products and other corporate objectives, Hatch continued. Working within this framework, the director can then see that the lab has adequate equipment and a good staff. His staff should be heterogeneous, including men with different technical specialties.

A successful lab must also have a psychological environment that encourages engineers to have ideas, he added. Creative people seldom work in an orderly smooth fashion but their chaotic ways must be tolerated if they are to produce results.

Once underway, each project needs a strong advocate in the lab, Hatch warned. Almost every project passes through a discouraging stage. Often a good idea has survived only because some individual has had a passionate belief in it and has carried the project on—sometimes even after funds are cut off.

Hatch also advised the director of research not to discuss a new project with management during its early stages. Management is technically unsophisticated, hence is not equipped to judge an idea until its development has progressed far enough for the director to show how it fits into company goals.

Dr. Louis E. Thompson, consultant, Norden Div, United Aircraft, told the group that much confusion and operational trouble has arisen because project managers believe they can save money and time by jumping immediately from idea to hardwear specifications. The development program for any weapons system, he said, should include parallel work on different component approaches. The exploratory work on components should continue until final specifications are set. The finished system will then include components that include latest state-of-the-art advances.

The increasing emphasis on research is certain to bring abundant rewards, Dr. Mervin J. Kelly, president of Bell Telephone Labs, told the group.

But if the potentials of research are to be fully realized, he said, the nation must more than double basic research and turn over the management of both basic research and advanced development work to men with intensive training in the sciences. Finally, he said, secondary and high school curricula must be overhauled so that students with engineering talents are equipped early with training in mathematics and physics.

1200 F Anti-Friction Material Announced

CLEVELAND—non lubricated bearings and seals may run hotter when made from wear-resistant sintered-iron powder mixture developed by Clevite Corp. As a seal material, rubbing coefficients of friction are in the order of 0.075 and below, from room temperature to 1200 F, at surface speeds as high as 150 ft/sec. Wear rates vary from 0.003 in./hr at 1200 F to 0.0007 in./hr at 500 F. Designated Clevite 300, it contains over 50% of low-cost ferritic iron, and runs best against itself, although 52100 steel will also work.

Compressed Air De-ices Bodies of Water in Sweden

STOCKHOLM—The village swans now swim all winter in the village pond at Laxa, Sweden . . . several sawmills can keep their lumber sluices working despite freezing weather . . . and the Harsfjarden Naval Station can keep its channels open.

These are some experimental applications of a de-icing system, using compressed air, developed by Sweden's Atlas Copco. Tests indicate this as an answer to a problem faced elsewhere in the world where industry needs clear-water facilities in winter: harbors, lakes, canals, and seaway areas.

The system, using perforated plastic tubing to release compressed air below the surface, accomplishes what Nature fails to do. Suppose you have a body of fresh water. With advent of winter, it keeps cooling—with surface water sinking and warmer water from below rising to take its place—until the entire body has reached max density at 39.2 F. Circulation now stops. Though the 39-F water below is warmer, it does not rise because its density is greater than the ice and icewater at the surface.

The Atlas Copco system prevents icing, or de-ices any layer already formed, by creating air bubbles that carry warmer water up to the surface. Its aerated streams rise vertically, then spread horizontally near the surface, giving ice-free areas 30 to 45 ft in diameter. In its use of perforated polyethylene tubing to distribute compressed air it somewhat resembles England's new method for calming the seas (*PE—Jan 12, p 12*).

Atlas Copco preferred polyethylene to galvanized iron piping because of its superior anti-corrosion properties, lighter weight and fewer maintenance problems. Also, while iron pipe required special nozzles to release the compressed air, holes can be drilled in the plastic tubing. Its brittleness in extreme cold is a drawback only when the tubing is removed from the water for repairs. Rubber hosing, currently too expensive, would be an improvement.

The technique requires only standard compressors. One installation, a reservoir for logs, uses about 36,000 ft of tubing in water covering an area of 750,000 sq ft that ranges from 12 to 100 ft deep. Air temperature here is about −31 F. Tubing installation costs—in Sweden—averages $1 per yd; power costs are 1¼¢ per kwh. Determination of the proper size of tubing is dependent on the amount of air fed into the system, depth of the water, and distance from compressor to outlets. Some installations, like a ferry route, requiring de-icing operations three months of the year. Here, a portable compressor would work, then be used elsewhere in non-winter months.

Problems still to be solved: (1) major natural water currents tend to disperse bubbles over too wide an area—result is diminishing melting effect at the surface; (2) severe winter weather renders the system inefficient if installed in water less than 33 ft deep; (3) subsurface water that is too cold (as little as 2° above freezing is satisfactory) requires excessive quantities of compressed air, increasing costs.

Sluice stays unfrozen . . .
thanks to compressed air bubbling up from below. At this inlet for carrying logs into a Swedish sawmill, 573 yd of polyethylene tubing is anchored at the bottom with steel wire.

Smaller Cyclotron—but Over Twice the Power

LOS ANGELES—A new type of cyclotron, with more atom-smashing power in a smaller package, is currently under construction at the Univ of California, Los Angeles. Called a spiral cloverleaf cyclotron, it presents a promising new design for getting around the voltage limitations of the conventional cyclotrons, according to its designers, Profs. J. R. Richardson, B. T. Wright and K. R. MacKenzie.

With the 49-in. spiral cyclotron, the UCLA physicists will be able to accelerate particles to 50 million electron-volts. In contrast, the larger 60-in. conventional cyclotron at the Univ of Calif, Berkeley, operates at a maximum of 20 mev.

Key feature of UCLA's cyclotron is its shape—like that of a child's pinwheel, with each of its four magnetic iron shims weighing 50 lb, and with a radius of 20½ in.

The spiral ridge design will allow continuous acceleration of particles, in contrast to the bursts of acceleration in present cyclotrons. Continuous acceleration is possible because the orbiting atomic particles are in constant angular speed and in step with the electric field that boosts their speed each time they make a cycle.

About half a dozen other spiral ridge cyclotrons are currently being planned or designed in various laboratories, but none has been tested or is as near completion as UCLA's version.

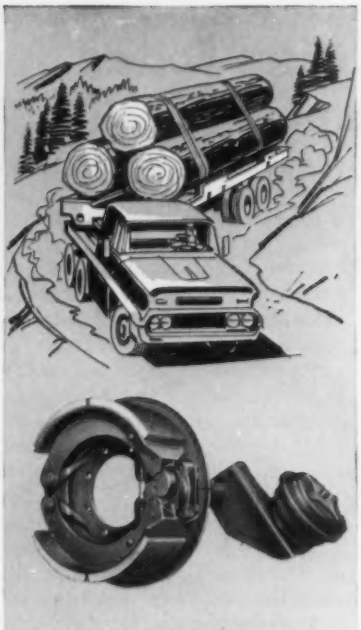
Construction on a more ambitious 88-in. spiral ridge cyclotron will start around next May at the Ernest O. Lawrence Radiation Laboratory at Berkeley.

Pravda Describes Space Vehicle Instrument Package

Moscow—A lengthy communique in *Pravda* has described flight, orbit, tracking and instrument package of the Soviet space vehicle launched Jan 2 and now orbiting the sun. *Pravda* promising a resume of scientific findings in a later issue.

Last stage of the interplanetary mis-

FSH Series Hydraulic Brake . . . unequalled stopping power and control for every application where heavy-duty braking is required. Floating shoes give even lining load distribution and close control in either direction of travel. Wide range of sizes for industrial, material handling and construction applications.



"P" Series Power Air Brake . . . for heavy-duty automotive service. Unit mounted design offers compactness and simplifies installation. Open-type spider assures good internal ventilation and rapid cooling for longer lining life. Outstanding features for greater performance, lower maintenance.

"T" Series Air Brake . . . an economical brake designed for a variety of automotive applications. Precision-forged, one-piece cam shaft. Constant, equal rate of lift to both shoes. Fabricated steel brake shoes combine strength with lightness. Brake linings up to ½" thickness. Complete range of sizes.

MORE THAN

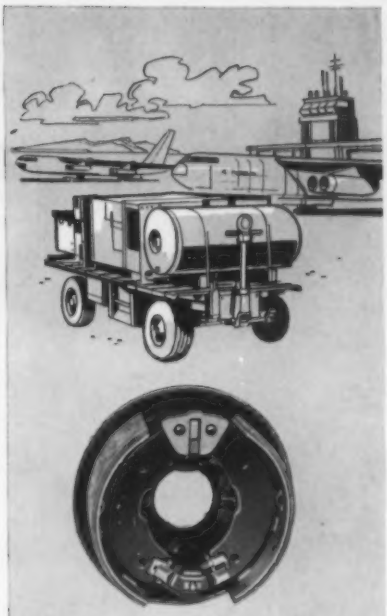
coming soon . . . the New Stopmaster Brake . . .

for both highway and heavy-duty off-highway equipment!

It's the most advanced new brake design in 30 years—bringing you faster, surer stops . . . cooler operating temperatures . . . lower maintenance costs . . . lighter weight for greater payloads! This new air or hydraulic brake is designed to meet today's increased braking demands.

Heavy-Duty "P" Series Air Brake . . . offers better control, greater dependability, longer service for heavy-duty off-highway applications. Unit mounted design for compactness. Open-type spiders for lower operating temperatures and longer liner life. Wide range of capacities and sizes.

"DLM" Series Mechanical Brake . . . primarily a parking brake for trucks, buses, cranes and shovels, it also is ideal for use on farm equipment, hoists, lift trucks and other applications. Self-energizing two-shoe design. Only 8 parts with interchangeable shoes and springs. No lubrication required.



"DM" Duplex Mechanical Brake . . . for farm equipment, special-duty utility trailers, light-duty highway trailers and industrial machinery. Two identical shoes do an equal amount of work in either forward or reverse direction. Positive braking with immediate response. Simple design for low maintenance.

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ROCKWELL-STANDARD BRAKES!

Whatever the size or type of brake you require . . . whether it's for an industrial, agricultural, construction, or automotive application . . . Rockwell-Standard's complete line offers a brake that is specifically designed for your purpose.

Products of over 40 years of leadership in brake design and manufacture, Rockwell-Standard Brakes assure the ultimate in safety, dependability, and trouble-free long life. Only Rockwell-Standard combines brake designing, engineering, testing and manufacturing in one integrated facility, to bring you the industry's most advanced brake products.

Every Rockwell-Standard brake design has been proven by rigid tests, both in the laboratory by trained technicians, and over thousands of miles of demanding road trials. It's just one more reason why you can be sure . . . your *best* brake is Rockwell-Standard!

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BRAKE DIVISION Ashtabula, Ohio

"POP" RIVETS

Insert and Set From Same Side
Cuts installation costs in half.

High Clinching Action
Pulls parts together with up to 600 lbs. squeeze. Eliminates need to clamp.

Wide Grip Range
Simplifies inventory, purchasing, inspection. Same length "POP" Rivet holds tight through thick or thin.

Vibration Proof
"POP" Rivets cannot back out or become loose. Ensures tight assembly for years of use.

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Where space is important, "POP" Rivets' minimum head height eliminates clearance problems and improves appearance.

Least Back-Up Space
Strong, high strength "POP" Rivets need only enough back-up space to provide room for set head. Gives more compact design.

- **Cut Assembly Costs**
- **Solve Design Problems**
- **Installed and set from same side**

"POP"® Rivets cut *installed fastener costs*, add design flexibility, and increase assembly convenience because they are inserted and set from the same side. Up to 1200 can be set per hour right on the assembly line — even by an unskilled operator.

"POP" Rivets are precision made, hollow rivets assembled on a solid high tensile mandrel. The setting tool pulls the mandrel head into the rivet from the front side, setting the rivet on the reverse side. Mandrel breaks under tension of up to 1600 lbs. and falls free.

You can cut installed costs, increase assembly convenience, and secure high speed, trouble-free fastening immediately with "POP" Rivets. No need for complicated or extensive re-tooling. Simplify product design, cut handling time. Call or write us today — now — and start cutting your *installed fastener costs* with "POP" Rivets! Or better still, send us a sample assembly for riveting.

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UNITED SHOE MACHINERY CORPORATION
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sile is described by *Pravda* as a "controlled rocket connected by a transitional fastener to the preceding stage." An automatic control system stabilized position of the rocket along its predetermined trajectory and ensured it would be moving at a predetermined speed when engines stopped operating. Without fuel, this stage weighs 3238 lb.

LAST STAGE CONTENTS

In addition to normal flight-devices, the last stage carried a container with scientific and radio instruments—included were two transmitters, a cosmic-ray counter, a radio system that helped Soviet trackers determine and predict flight path, and equipment for an artificial sodium comet.

The 794-lb instrument container housed in the upper part of the missile's last stage was protected from overheating in the earth's dense atmosphere by a cone that was discarded in space. The container is made of two hemispheres of thin, magnesium-aluminum alloy, joined hermetically by frames with a "special rubber" packing. It was filled with gas at 1.3 atmospheres and 80F. Temperature of this gas is kept constant—the shells were specially treated so that definite coefficients of reflection and radiation can be maintained. In addition, a ventilator in the chamber circulates the gas, which draws heat off the instruments and carries it to the shell.

A magnesium-alloy instrument holder of tubular design was fastened to the lower frame of the half shell to hold the instruments. Silver-zinc and oxidized-mercury batteries on the instrument holder provide electricity for the instruments and equipment.

MORE DESIGN DETAILS

Four rods of the transmitter's antenna were placed on one of the hemispheres. Until the protective cone was discarded, the antenna was folded and fastened to a pin by a magnetometer.

The same shell carried two proton traps for detecting gases in interplanetary matter and two piezo-electric gages for studying meteorite particles. Each photon trap consisted of three concentric electrodes of 16 mm radii. The unit for producing the artificial sodium comet was designed to evaporate 2.2 lb of sodium each 5 to 7 sec and to discharge the cloud into a vacuum under conditions of weightlessness. An electronic device with a quartz clock gave a signal to switch on the evaporator.

De Gaulle Names 'Research Minister'

PARIS—A "minister" in charge of research has been appointed by Prime Minister de Gaulle to supervise France's research program—pure and applied—costing 120 billion francs a year ($240,000,000).

Named to the new post is Pierre Piganiol, former research chief for the big French glass manufacturer, Saint Gobain. He will report directly to the prime minister, who, under the reorganized setup, is president of a committee of cabinet ministers responsible for the government's research program and budget. A dozen leading scientists serve as a consulting committee to this governmental committee, which includes the ministers of education, finance, armed forces, industry and commerce, agriculture, and public health. Backing up the two committees is a common secretariat headed by Piganiol.

Principal purpose of the reorganization, Piganiol told PRODUCT ENGINEERING, is to bring governmental research expenditures in line with the country's over-all needs. He underlined the inter-ministerial committee's three essential tasks:

- **To insure an equitable distribution of funds among the various kinds of research—fundamental, technical and applied.**
- **To insure optimum use of the nation's research facilities and personnel.**
- **To keep abreast of research developments likely to be important to the country as a whole.**

Piganiol emphasized there is no present plan to centralize the government's research facilities, now operated by several different ministries, under one administration. "We intend to integrate the research program," he said, "with the least possible change in the existing structure." As an example he pointed to the way the government will attack space research. A committee of space-research experts will determine what France can reasonably expect to accomplish in the field; then the committee will recommend how the work should be split up among existing research facilities or, if necessary, propose that a space-research center be established.

Pathon Series WAL...WHL

AIR AND LOW PRESSURE HYDRAULIC

Cylinders

You can improve the durability and appearance of your equipment with the new Pathon W Series Air and Low Pressure Hydraulic Cylinders.

Valuable space can be saved with these proven screw thread head units. They are available in all standard mounting types plus the type 8, intermediate flange mount (illustrated above) in bore sizes from 1⅛" thru 6".

Specify WAL for air or WHL for oil service to 200 psi. These economical units incorporate non ferrous barrels, hard chrome plated rods, and "U" cup rod packing for minimum friction.

Specify WAT for air service to 250 psi; or WHT for oil service from 350 to 500 psi, depending on bore size. These units incorporate hard chrome plated steel barrels, case hardened, chrome plated rods, and multi-lip rod packing.

All Pathon cylinders have externally replaceable rod packing.

Write for Bulletin #25

Pathon MANUFACTURING COMPANY

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A-59

FLUID OPERATED AND CONTROL EQUIPMENT

At Eastman

the question of color in plastics

has over 39,000 creative answers

Eastman's Leadership in Color Creativity Has Produced Tenite Plastics in a Range of More than 39,000 Colors

To get an answer, you have to ask a question.

Users of Tenite plastics have asked enough questions since 1932 to make it necessary for Eastman color technologists to create formulations that will soon total 40,000 different colors and color effects.

While an untrained person may think of colors only in terms of the basic spectrum, his eyes usually are perceptive enough to detect even a minute variation when two colors are placed side by side. To such an eye, a new automobile interior would look disturbingly "wrong" if there were the least bit of difference between the color of its upholstery and its matched plastic appointments such as steering wheels, arm rests or control knobs.

Accurate color matches, therefore, are a vital concern to all manufacturers of plastic products that must be used in harmony with other colored materials of different surface texture, density or reflectivity such as painted wood, enameled metal, colored tiles or textiles. And, as color becomes more important in product design and merchandising because of its sales-stimulating effect, the attendant problem of proper color matching becomes even more critical.

Since 1932, when Eastman began to produce plastics, it has developed and kept on file, formulations for over 39,000 colors. This experience, plus Eastman's pre-eminence in color photography and textile dye technology, makes it possible for customers to depend on Eastman for the broadest range of colors available in the entire plastics industry.

In many instances, of course, customers can solve their color selection problems merely by consulting the extensive files of color chips available at every regional Tenite sales office. More extensive research in color matching can be carried out at the Tenite Color Laboratory in Kingsport, Tennessee. Here, the user of plastics is invited to work out his color problems in cooperation with a trained staff of color technicians.

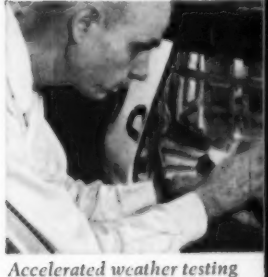
Every day, some 15 to 20 requests for color matching are received by the Tenite Color Laboratory. These are submitted through regional Tenite sales representatives in the United States and Canada and through numerous Eastman affiliates abroad. The color samples submitted for matching include almost every known material—textiles, metals, tiles, wood, rubber, other plastics, paint and many more.

Four days usually are sufficient for the color technicians to make the match. For highly critical applications, as in the automotive industry, where there are many complicating factors of texture and density, the technician often submits several tentative matches.

When a sample arrives at Kingsport, the first step is to search for a possible match among the color chips in the Laboratory file. Frequently, one of the more than 39,000 chips of Tenite colors already developed may match the sample perfectly. If a match is found, the next step is to supply a trial batch

Thousands of colors on file

Milling the trial color



Accelerated weather testing

Color creativity depends on color research

of colored Tenite pellets to the customer.

When no formulation on file permits a match, the Laboratory proceeds to create a new color formulation. The technician first takes advantage of Eastman's 26 years of past color creativity—by selecting existing color chips of the nearest color matches and noting their colorant formulations. These provide him with helpful references for which there is no substitute. Drawing on the performance of colorants in many previous tests and in their actual finished or processed state, the technician avoids time-consuming delays of trial and error. He is assured that the colorants are easy to disperse, are compatible with the plastic mass and the plasticizer, and that they possess the maximum resistance to migration and the attacks of time, light, weather and temperature that limitations of availability will permit.

As he weighs out the colorants to make the new match, the technician varies the formulations of the nearest matches, adjusting them to approximate the exact color needed. When variegated, pearlescent or metallic effects are wanted, the technician must deal with the result of combining the components as well as with the color match. Often, he relies on intuition—disciplined by years of experience—to create a totally new and striking effect for the customer.

In the next operation, components of the formulation are blended together on milling rolls to insure homogeneous dispersion. Color chips are then molded from this test batch, and evaluation begins.

If surface coloration is the only critical factor, visual or "eyeball" inspection usually suffices to confirm the match. But even here, the technician must bring his highly specialized judgment into play. He must consider the visual implications of the two textures and their psychological effect in determining acceptance of the color in plastic as the proper match for the color in another material. In addition, over-all size and shape as well as contour of the original sample complicate his color matching efforts.

When light transmission is to play an important role in the end-product, the technician turns for conclusive guidance to the spectrophotometer. This precision instrument measures the length of light rays, and its findings permit formulation of properly translucent colors when transmission ratings must be held within limits dictated by the end-use.

If the color fails to duplicate the sample either by "eyeball" or spectrophotometer testing, the matching process starts all over again.

Finally, when the color technician is satisfied that the color match is accurate and that it can be supplied in commercial quantities within the prescribed limits of commercial acceptability, he makes a detailed record of the new formulation in the Tenite Color Laboratory file.

Careful detailing of the formulation is one of the most important steps in the color matching operation—for the success of full-scale production depends upon the accuracy with which the formulation has been recorded.

With the writing and filing of the formulation, another customer has had his color question answered—*and another color has been created by Eastman.*

The full story of the color resources that back up the Eastman plastics—Tenite Butyrate, Tenite Polyethylene and Tenite Acetate—is told in a 20-page booklet, "COLOR." For your free copy or more information on these plastics, write to EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

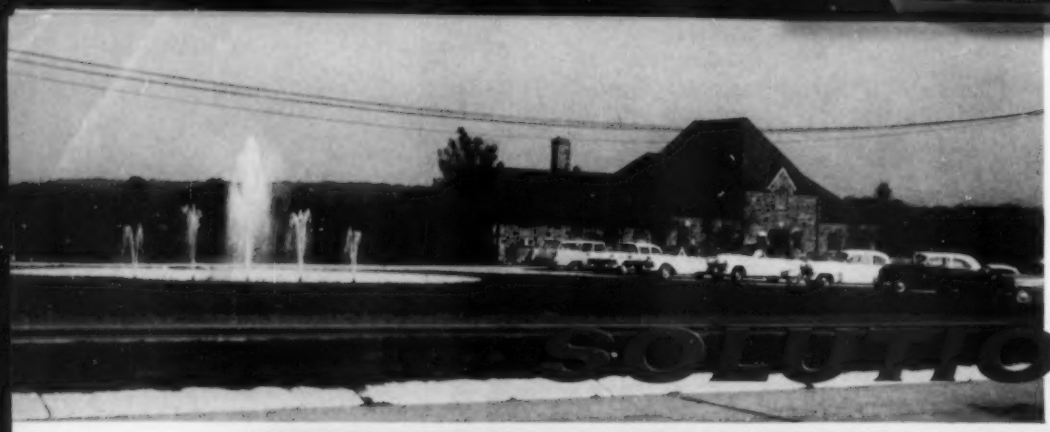
Judging the match

TENITE

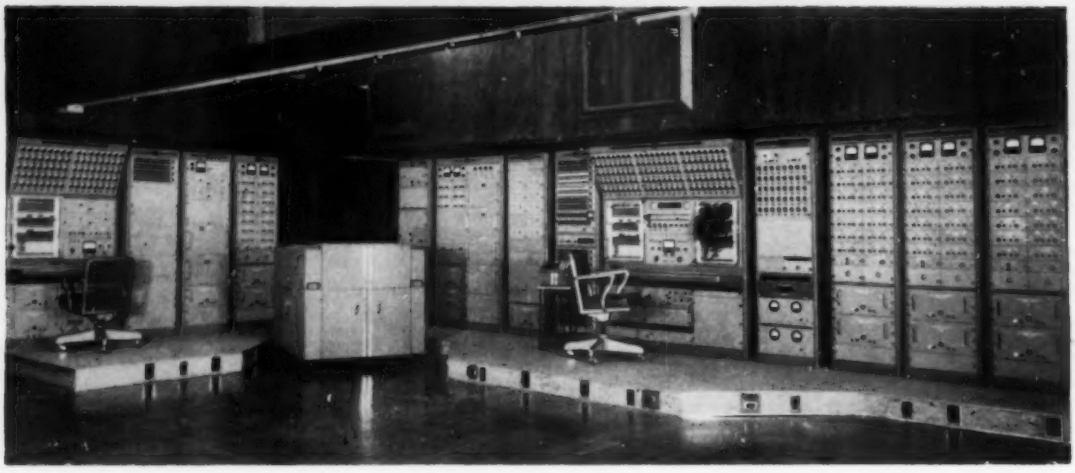
BUTYRATE • POLYETHYLENE • ACETATE

Colorful plastics by Eastman

CIRCLE 61-62 ON READER SERVICE CARD



SOLUTION by



What makes analog computers different from digital types? Easier to understand and operate—ideal for control or design problems—analog computers are taking their place beside the designer as a most versatile tool and his product's most important component.

RICHARD M KOFF Senior Associate Editor

If you have been ducking written articles and passing over discussions on the analog computer; if words like scale factor or patch panel have only the vaguest of meanings to you–you're out of step and falling behind fast. Analog computers are finding their way into more industries, engineering departments and even consumer products every day. Many of tomorrow's problems will be solved by computer; either you learn to live with them or reserve your rocking chair early.

What does analog mean?

In an electrical analog computer, physical quantities (velocity, dimension, etc.) are represented by voltages–quantities that can be easily read off in the form of numbers on a meter, oscilloscope or recorder. Each mathematical operation (summation, multiplication, integration) is performed by a group of electronic components (the electronic engineer's beloved black box).

Inputs to and outputs from these black boxes are wired to a patch panel–a perforated board resembling a telephone switchboard. A specific problem (that is, the sequence of mathematical operations that results in an answer) is set up on the computer by interconnecting suitable black boxes with short lengths of wire on the patch panel.

A bank of potentiometers provides fixed (but controllable) voltages to the operating black boxes. Constant multipliers, for example, are set by turning a potentiometer knob. Answers are voltages which may be read on a meter, traced on oscilloscope or oscillograph, or even printed out by digital voltmeter.

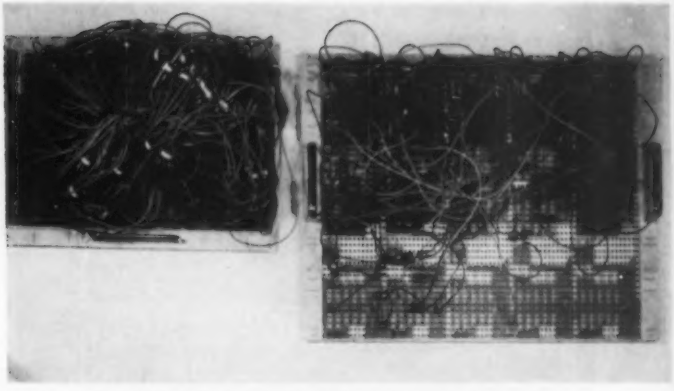
That's all there is to it. Equations are solved by the engineer himself. He sets them into the computer almost the way he would write them on paper. With the aid of the computer he can handle problems faster and with less chance of error; and even solve problems that have no classical longhand solution.

Digital computation is different

The digital computer includes: an arithmetical unit capable of doing elementary addition and subtraction, a memory that stores numbers between calculations, a master control which directs the sequence of operations, and input-output devices like an electronic typewriter, punched-card readers, magnetic-tape readers.

The computer solves its problem in a series of extremely simple operations. A number is taken from an indi-

ANALOGY



In a sylvan setting near Princeton, N J, Electronic Associates Inc. installed an analog computer, a staff of scientists, and an atmosphere of quiet competence. Here a customer solves his problems with as much assistance as he cares to buy—from five minutes on the computer to full-scale analysis, block diagram, computer simulation and final report.

Patch panels are the master controllers of an analog computer. Plugged interconnections effectively set up a block diagram right in the computer. Replacement of the panels permits efficient use of computer time.

cated location in the memory and put in the arithmetical unit. A second number is added to it and the sum put in another location in the memory unit. A program stored on cards or tape itemizes the sequence of operations and checks to see that no errors are made, nothing left out.

Repeated often enough, this sequence is the equivalent of multiplication, integration or any combination of complex mathematical functions. Only extreme speed makes the process economical, and digital computers work fast. Manufacturers now talk of "40,000 additions per second."

Which is better?

It would be wrong to say that one kind of computer is better than another, but one can point to general types of problems more easily or economically solved on one or the other.

A digital computer can store and manipulate large masses of data—that is why it was first, and is now so widely used in inventory control, payroll calculations and other business problems. Like the accountant, it is accurate to the last decimal place—no matter how large the number. It can store alphabetical (names, addresses, etc.) as well as numerical data and is ideal for repetitive calculations—the more cycles the better. It is well suited for matrix calculations, logistics, linear programming, operations research and many statistical problems.

The familiar image of 100 mathematicians with 100 desk calculators taking 100 years to solve some problem which the digital computer does in one minute is perfectly true, and often conservative. But the "mathematicians" could be low-grade morons—needing only patience and the physical ability to punch a number on the machine.

The digital computer is a low-grade moron who punches buttons very quickly indeed. It must be told precisely where to find the number, the keys, and where to print the answer. And these instructions must be repeated every time—40,000 times a second if need be.

By contrast the analog computer is a genius. The analog computer solves a problem by imitating, in electrical form, the exact mathematical relationships of the prototype. The imitation substitutes computer black boxes or groups of boxes for real components in the true world. Therefore when an operator wishes to change a real-world characteristic, he simply adjusts the applicable black box. And it is far easier to hook up a new black box or switch a couple of leads than it is to change the wing span of a real airplane or switch generators in a power station.

Further, the time for a reaction to take place can be magnified or reduced at will. If an oven takes a half hour to heat up to temperature, the computer simulation might reduce this to a half minute of computation time. Conversely a superfast chemical reaction—too fast to measure, much less to control—might be stretched out, in computer terms, for minutes or even hours to permit careful analysis of every step in the reaction.

So the analog computer is a natural for engineering problems. Structures may be analyzed for stress or heat transmission, servo systems for stability or accuracy, hydraulic components for flow or pressure characteristics; in fact any physical system that can be approximated by mathematical equation is solvable on analog computers.

Further, the same principles of computation may be

SOLUTION by ANALOGY

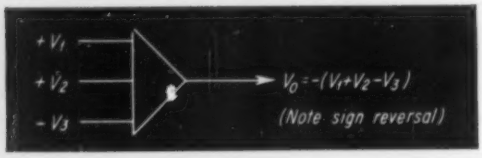
THE SAMPLE PROBLEMS on this page show, in simplified form, how a computer actually solves a problem.

The basic idea of electrical analogy is the fact that the equations that describe an electrical circuit can be exactly the same equations that describe a mechanical system. Circuits are easy to make and change whereas mechanical systems are often bulky and expensive.

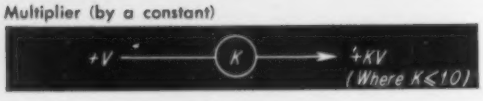
Analog computers are simply collections of circuit elements with provision for hooking them together so that a particular mathematical relationship is obtained.

Six simple computer components take care of most problems. They may be symbolized as follows:

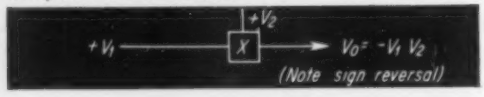
Summer (for addition and subtraction)



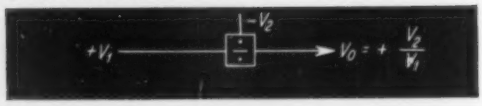
Multiplier (by a constant)



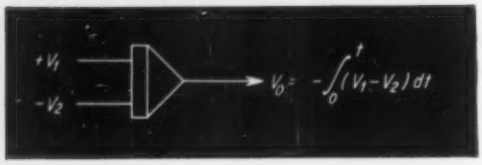
Multiplier (of two variables)



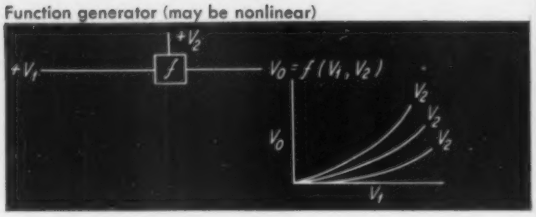
Divider (two variables)



Integrator (and summer)

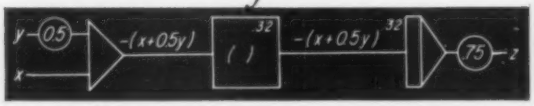


Function generator (may be nonlinear)



Let's try a simple equation:

$$z = 0.75\int (x + 0.5\ y)^{0.32} dt$$

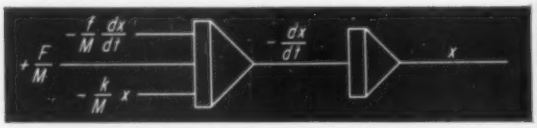


In essence this is simply a system of block diagramming. Interconnections between blocks are interconnections between black boxes made at the patch panel

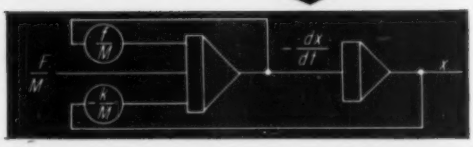
And now, a real life problem. Here is the familiar spring-mass system and its equation of motion:

The block diagram is drawn by solving the equation for the highest order derivative.

Assume everything to the right of the equal sign is available. Sum and integrate twice:



Now add the feedback loops to make the inputs. Note the sign reversal comes out just right.



The parameters (F, f, k and M) are simply set on potentiometers and may be varied at will.

applied to control. Special-purpose computers differ only in size (they're smaller) and the black boxes are wired together permanently. Fire-control equipment, automatic pilots and navigators, rocket and missile guidance systems are all controlled by analog computer in one form or other.

Where are they going?

About 100 general-purpose computers were shipped in 1958. This is probably double the shipments in 1955, and sales may well redouble during the next three years. It has taken a while, but engineers of all specialities are beginning to realize the potentialities of electrical analogy. Resistance to innovation ("We've got a technique for solving that. It's familiar and adequate. Who cares if it's slow?") and the mechanical engineer's traditional aversion to electrical terminology and concepts have delayed the acceptance–but things will be moving fast from here on out. ■

REPRINT of this article can be obtained for your reference file by writing E63 in the space marked "Special Data" on the Reader Service card facing the inside back cover of this issue.

VOL. 3—NO. 4

NEWS OF MATERIALS THAT ARE IMPROVING TODAY'S PRODUCTS

THE NATIONAL SCENE

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PUBLISHED BY NATIONAL VULCANIZED FIBRE CO., MANUFACTURERS OF:

VULCANIZED FIBRE • PHENOLITE® LAMINATED PLASTIC • NATIONAL NYLON

NEW NATIONAL MATERIALS DELIVER LOW-COST FLAME RETARDANCE...RELIABLE HEAT RESISTANCE

Permit designers to add new product features at little or no added cost

Out of National's R & D labs come new self-extinguishing materials . . . for structural parts and for printed circuits. They offer manufacturers new opportunities to broaden the use of flame-retardant materials in many of their products without increasing costs.

PYRONIL: combines flame retardance with most of the well-established structural properties of Vulcanized Fibre.

PHENOLITE XXXP-475: offers a self-extinguishing paper base laminate for printed circuit use. Made without the use of costlier resins, material can be precision-punched at warm temperatures (130°F.-150°F.).

A new high temperature material, PHENOLITE GH-871, offers excellent flame-retardance as well as very good electrical properties. Of special interest to: rocket, missile, aircraft and electrical apparatus design engineers.

The table below compares these and other flame-retardant materials available from National. Principal known uses are noted. For more information use coupon on page 3.

What is a high temperature material?

New laminate, GH-871, retains 64% structural strength after half-hour exposure at 650°F. See full test story on pages 2 and 3.

The present need for materials with reliable performance under exposure to high temperatures has stimulated much interest in data on "heat-resistant" grades of laminated plastic. There are such materials available, and there will be more.

The problem of selection by the designer, however, is not made easier by *availability* of these materials, but in fact, is made more complex by an absence of test *standards* on which to base reliable data. This has resulted in claims about materials which tend to be confusing since they are not supported by standard test procedure.

Transformer insulation, for example, is expected to retain its electrical and mechanical properties for perhaps 20 years without deterioration at 350°F. temperatures. Such materials are available and performance tests are standard. Missile engineers, on the other hand, are concerned with the performance of, say, a thermal insulator under temperatures as high as 25,000°F. for only a few seconds. Here,

Continued on Page 2

FLAME RETARDANT MATERIALS

GRADE	TYPE		FLAME RESISTANCE			Mechanical Strength	Electrical Properties	Moisture Resistance	AIEE Insurance Class	Typical Applications
			UL (1)	NEMA (2)						
	Base	Resin	Time (Sec.)	Ignition Time (Sec.)	Extinguishing Time (Sec.)					
Pyronil	Cellulose	None	<1			Fair	Poor	Poor	A	Flame Barrier
X-121	Paper	Phenolic	2-4	115	60	Good	Fair	Fair	A	Switchgear
X-122	Paper	Phenolic	1	120	60	Fair	Fair	Fair	A	Switchgear
XX-326	Paper	Phenolic	1½-2	130	50	Fair	Good	Good	A	Switchgear
XXXP-467	Paper	Phenolic	<1-3	*	*	Fair	Excellent	Excellent	A	Printed Circuits
XXXP-475	Paper	Phenolic	<1-1½	*	*	Fair	Excellent	Excellent	A	Printed Circuits
GP-9202	Glass Mat.	Polyester	<1	not available	not available	Good	Good	Fair	B	Switchgear
GP-9204	Glass Mat.	Polyester	<1	93	347	Good	Good	Fair	B	Switchgear
G-5-813	Glass Cloth	Melamine	<1	250	55	Excellent	Good	Fair	B	Aircraft
G-7-832	Glass Cloth	Silicone	<1	104	63	Excellent	Excellent	Excellent	H	Radar Parts
GH-871	Glass Cloth	Phenolic	<1	257	59	Excellent	Good	Excellent	B	Missile Parts

(1) Underwriters test ⅛" thick specimen held horizontal 10 sec. in gas flame. Results are extinguishing time in seconds.
(2) Proposed NEMA Switchgear Committee test using modified Bureau of Mines apparatus. Results are ignition time and extinguishing time in seconds on ½" x ½" x 5" specimens
*Not made in ½" thickness required by Bureau of Mines test.

What is a high temperature material? (Continued)

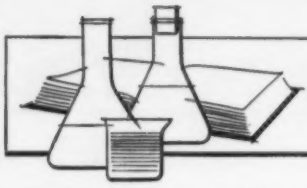
there are no standard tests, and unless the materials are tested under actual conditions there can be no basis for evaluating their true potential.

Another example. Vulcanized Fibre has been shown to withstand 22,000°F. for 10 seconds without serious weight loss. But the same material cannot be recommended for continuous operation at temperatures exceeding 200°F. To a lesser degree, the same wide temperature range is evident for all plastic materials.

National's new high temperature laminate. PHENOLITE GH-871, is a good example. It has been tested at 650°F. After one-half hour exposure *at* that temperature, GH-871 was tested *at* peak temperature within the oven and was found to retain 64 per cent of its original structural strength of 65,000 psi. Tests have also been made *at* 700°F. (See table below.) It is not known at present what the strength retention would be at much higher temperatures over a period of a few seconds. This new material holds promise for high temperature use. But only test data under specific use conditions will determine its full potential.

The table below shows the performance of six National materials known for their resistance to higher temperatures within the range of presently available test equipment. This information may provide a basis for selecting a material which must perform at higher temperatures than noted here, depending on what is required and for how long.

With National's research activity focused on high temperature performance of laminates, we welcome the opportunity to work closely with users in arriving at a satisfactory material to perform a given job. Use the coupon on the next page, or write us of your specific need.



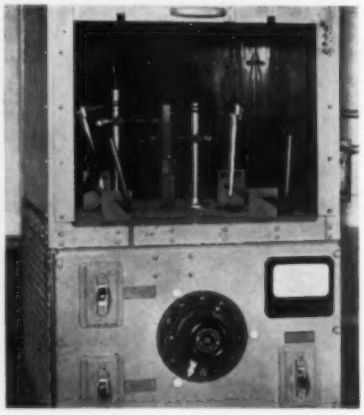
OUT OF THE LABS

The need for new laminates with higher heat resistance has been a critical design problem for more than five years. Although new resins were available that would withstand 500°F., it remained for National's Research and Development Laboratories to perfect them into a practical high temperature laminate.

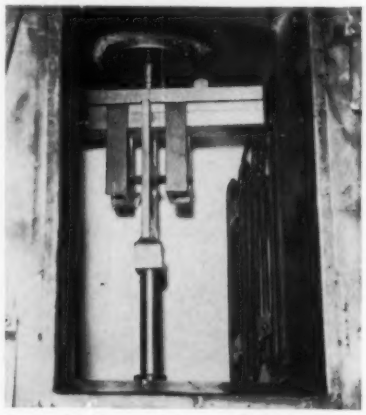
Case in point: Designers were asking for a high temperature glass-base laminate that gave the added features of mechanical strength, low water absorption, flame resistance and good electrical properties. The problem: Make it.

Solving the problem: National's Laboratories conducted extensive evaluation programs not only to find one best type of high temperature resin for this application, but also to come up with the strongest possible grade of glass cloth for laminate strength. This done, they turned their attention to the problems of manufacturing the new laminate. A typical one that had to be solved was the occasional blistering or delamination of thick sections during an oven-curing process. (Oven-curing is essential for high heat resistance.) This problem was answered by modifying both the resin and the laminate manufacturing process.

Result: When all such problems were solved, National had developed and tested the new PHENOLITE Grade GH-871 described elsewhere in this issue. This material's heat and flame resistance plus its ability to retain 95-98% of its flexural strength at 500°F. and 60-70% at 650°F., hold promise for solutions to a number of high temperature material problems.



Test piece in position for Bureau of Mines flame retardant test.



Heat chamber used for high temperature flexural strength tests.

HEAT RESISTANT MATERIALS

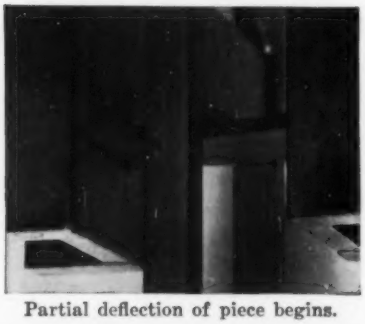
GRADE	TYPE		Initial Flexural Strength psi	Flexural Strength Retention			Electrical Properties	Typical Application
	Base	Resin		Temperature	Time	% Retained		
AA-761-A	Asbestos Cloth	Phenolic	20,000	300° F 500° F 500° F	1 hr. 1 hr. 100 hrs.	85 79 35	Poor	Rotor Blades
G-3-822	Glass Cloth	Phenolic	30,000	482° F	24 hrs.	95*	Fair	Motor Insulation
G-5-813	Glass Cloth	Melamine	55,000	392° F	24 hrs.	49*	Good	Switch Panels
G-7-832	Glass Cloth	Silicone	40,000	356° F 482° F	1 hr. 48 hrs.	33 97*	Excellent	Class H Transformers
G-11-861	Glass Cloth	Epoxy	68,000	302° F	1 hr.	70	Excellent	Printed Circuits
GH-871	Glass Cloth	Phenolic	65,000	500° F 650° F 700° F	100 hrs. ½ hr. ½ hr.	80 64 50**	Good	Missile, Rocket, Aircraft, Switchgear

*Tested at room temperature; other values at conditioning temperature. **Slight blistering.

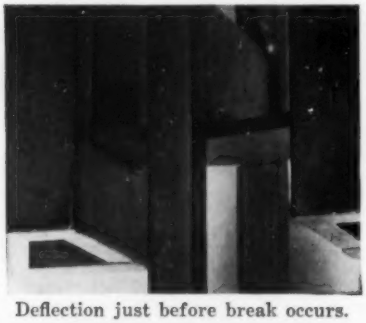
GH-871 Retains 64% Strength After Half-Hour at 650° F.

Flexural strength test of National's new laminate, PHENOLITE GH-871, is made while in an oven (see Out of Labs story) *at* 650°F. until fracture takes place. The photos below were taken at intervals during actual test.

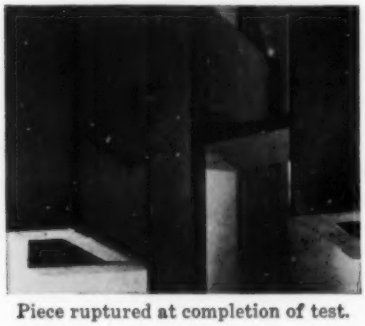
Piece in position. Force is applied.



Partial deflection of piece begins.



Deflection just before break occurs.



Piece ruptured at completion of test.

Epoxy Printed Circuit Laminates Offer Better Performance in Critical Uses

The "workhorse" of the printed circuit laminate field—XXXP—has been joined by a number of other important grades in recent years. Perhaps the two most significant are glass base epoxy grades G-10-865-1 and G-11-861-1. The table to the right compares these two with the more familiar XXXP.

The G-10 designation refers to standard epoxy glass material meeting MIL-P-18177-B, Type GEE. The G-11 designation refers to the newer heat resistant types. PHENOLITE grade G-11-861-1 meets both type GEE and GEB requirements under MIL-P-18177-B.

Rating of 10 indicates best of materials compared.

Because of the wide cost variance (approximately 3 to 1), G-10 and G-11 cannot be considered competitive with XXXP. But where maximum dimensional stability, higher strengths at normal or elevated temperatures, plus excellent resistance to chemicals used in various etching processes are required, G-10 and G-11 are worthy of consideration by the printed circuit designer.

PROPERTIES COMPARATOR CHART

	COPPER CLAD		
	XXXP	G-10	G-11
Dimensional Stability	2	8	10
Heat Resistance	2	6	10
Copper Bond Strength	7	10	8
Dip Solder	5	10	10
Resistance to Plating and Cleaning	4	10	10
Fungus Resistance	5	10	10
Mechanical Strength—Normal Temperature	2	10	10
High Frequency Losses	6	10	10
Arc Resistance	1	10	10
Water Absorption	5	10	10
Fabrication	10	5	2
Thickness Tolerance Copper Clad	10	6	6
Insulation Resistance C-96/35/90	9	9	10

NATIONAL VULCANIZED FIBRE CO.

Dept. NSC-1, Wilmington 99, Del.

Use this handy coupon to get the literature you want.

☐ A. New Materials Selection Guide 16 p.

☐ B. Fabricated Parts Booklet 8 p.

TECHNICAL DATA SHEETS

☐ C. Pyronil Flame Resistant Fibre

☐ D. Phenolite GH-871

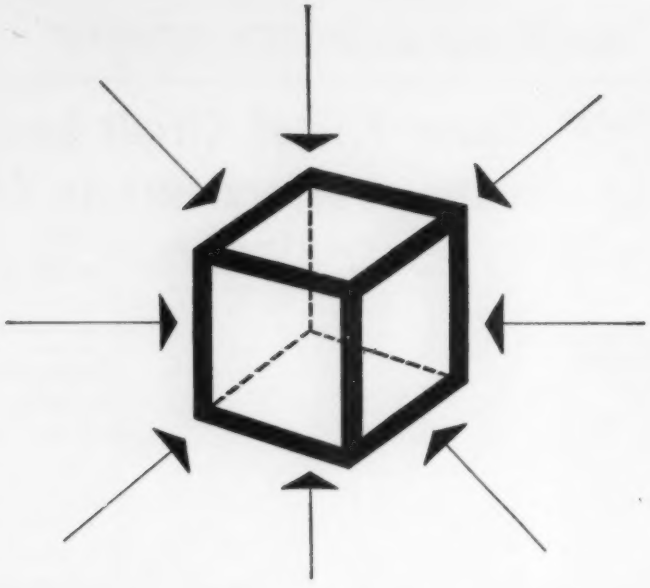
☐ E. National Nylon

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____



YOU MAY BE JUST THE MAN TO HELP BURROUGHS SQUEEZE A MILLION TRANSISTORS INTO A CUBIC INCH

OR EXPLORE FIELDS LIKE THESE:

- Statistical approaches to physiological processes
- Electro-chemical phenomena
- Radiation effects
- Plasma physics
- Magneto hydro-dynamics
- Electro-luminescence
- Cryogenics
- Superconductivity
- Semi-conductors
- And a lot of others

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Are you as outstanding as these opportunities? Then outline your education and experience as briefly or fully as you wish, name the field you'd like to help us explore, and get that information to A. L. Suzio, Administrator, Corporate Placement Services, Dept. 109, Burroughs Corporation, Detroit 32, Mich.

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"NEW DIMENSIONS / IN ELECTRONICS AND DATA PROCESSING SYSTEMS"

FIVE STEPS TO FASTER READING

LESSON IV . . .

By THE READING LABORATORY INC

In the first three "lessons" we covered the basic step in reading improvement—phrase reading. You learned to pre-read PRODUCT ENGINEERING, articles and reports, books, newspapers, and letters. This article will present several ways to improve your concentration. You have probably had the exasperating experience of waking up to find your eyes halfway down a page with your mind far, far away. Poor environment, a cluttered mind, and lack of involvement are the major concentration blocks.

Have a good reading environment. Control your lighting. Eye fatigue and visual strain account for a large part of distraction. Have a good, bright reading light falling on your book, with no obstructing shadows. Eliminate glare by placing another light of equal intensity in another part of the room. Choose a location for reading and research where interruptions will be at a minimum. Don't be too comfortable. Try for a compromise between relaxation and tension. A little tenseness helps you to stay alert. Finally, as much as your schedule allows, try to make your reading time and place habitual. You will begin to associate the time and location with concentrated reading efforts. Habit will become a help.

Eliminate reading distractions. The human mind, of course, is always cluttered. But you can push distractions away from the center of your attention by taking some kind of action. The least troublesome distraction is one that you can do something about. Write the letter that is on your mind, make the phone call you've been putting off, straighten out your desk if its disorder is annoying you. Then you can read with a free mind.

If you are distracted by a particular worry, a problem which can't be solved by immediate action, dispose of it by making a tentative decision for the future. When you are troubled by an apparently unsolvable problem or one of those indefinable feelings of anxiety, when you have suffered personal sorrow, you obviously can't take action. But you can try to push the worry back in your mind. As long as you can't solve the problem, promise yourself that you'll use fruitfully at least thirty minutes for reading—suspend worry for that period. A time limit helps do this consciously.

If you have no particular worries or problems but still have trouble concentrating, you are allowing yourself to become a passive reader. Boredom is generally caused by lack of involvement. If you do not understand baseball and you don't care who wins, you will be bored at a baseball game. Perhaps football is a different matter: You're interested in the plays and you want the Ypsilante Monsters to win. The game is over before you know it.

Reading works the same way. You must be interested in the "plays," or what the author is trying to put across as well as his method of writing. You must care about what you are reading. This means reading with a purpose. Always be conscious of your purpose; if you don't know why you are reading, don't read.

Read intensively to learn as much as you can in as short a time as possible. If you relax and allow your mind to wander, concentration is lost. Set yourself a time limit.

No matter how fast you read, you will not always get enough from the printed page to occupy your mind fully. You must re-direct your left-over attention into the article by asking questions. After you have pre-read, set up questions for yourself. What is the author's main thesis? Why is he writing the article? (Does he have an ulterior motive? What conclusions does he want the reader to draw?) Is his argument well-developed? As you read the article thoroughly, turn the topic sentence (generally the first) of each paragraph into a question. Look for the answer in the paragraph. For example:

> Rubber hose is not usually recommended at working pressures about 1000 psi.
>
> **Why not?**
>
> Flexible metal hoses are generally limited to pressures of about 750 psi, although reinforcement and several-ply construction can increase this to over 3000 psi. Even at relatively low pressures, 200 psi or more, a section of hose can become nearly as rigid as a piece of metal pipe.

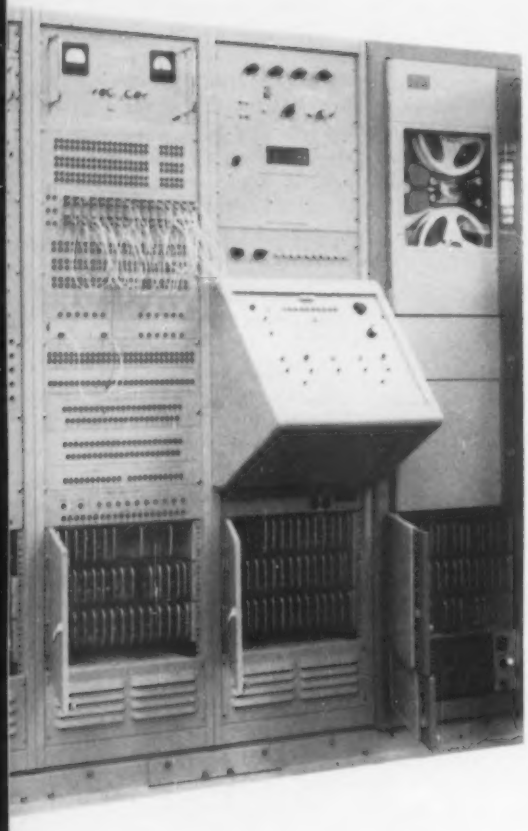
One more tool for increased concentration is the anticipating technique. Having pre-read, you will be familiar with the author's main arguments. Try to anticipate the way he will develop these arguments. Predict for yourself the next idea he will introduce. Keep your mind two steps ahead of your eyes. Don't let the author get the upper hand.

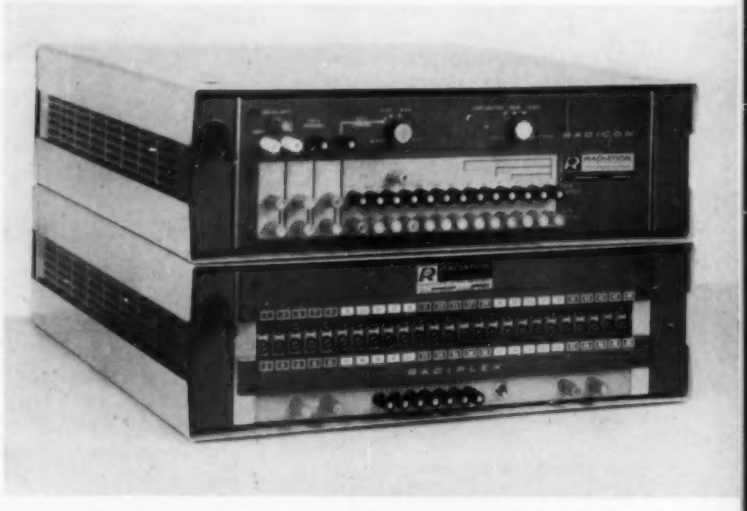
By controlling your reading environment, by taking action to clear your mind, by becoming involved with your reading by questioning and anticipating, you will be able to improve your concentration markedly. The conscious effort and constant practice you devote to improving your powers of concentration will pay dividends in speed and comprehension. ■

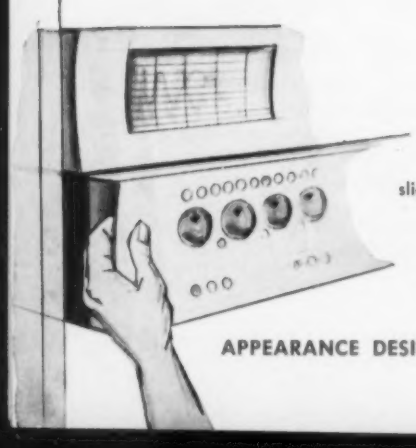
A more complete discussion of all-aspects of reading improvement, plus practice exercise, is available in the book *Cut Your Spending Time in Half, written* by The Reading Laboratory and available for $1.25 from its publisher, Developmental Research Institute Inc., Dept. E, 500 Fifth Ave., New York 36.

TRENDS

in appearance design...







Typical rack-mounted installation of data-processing equipment is at left, above. Redesigned units (top picture, front panels; lower, rear or connection panels of same equipment) demonstrate disciplined arrangement of data display, grouping of controls and other elements into functionally related, easier-to-use patterns. U-shaped bar handle traditional in electronic equipment is eliminated. Hand grips are now integral, consisting of slightly concave aluminum panels, projected forward from housing about 1 in.

. . . two examples of data handlers

The equipment (opposite page) manufactured by Radiation, Inc, Melbourne, Fla, translates data from research apparatus or control systems into forms for permanent records or use by computers. Developed originally for the government (but now handling industrial and commercial tasks too), these units are custom-built—but generally of the same basic components. Radiation's management realized that if these could be re-designed on a modular basis, it would pay off in future design and production. First step was an objective analysis of the product line, with the help of industrial engineer Raymond Spilman, New York.

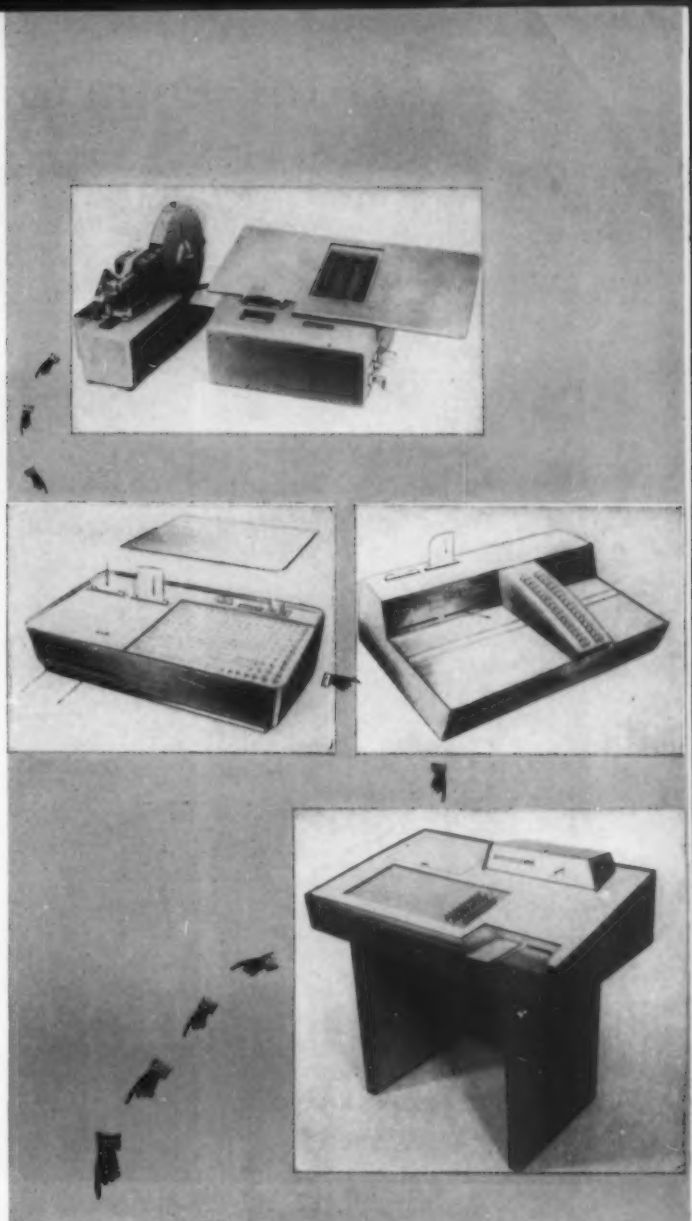
Allowance had to be made for the various jobs where any new designs would likely be applied. Ruggedness, ease of handling, mounting and maintenance were musts—yet size reduction was imperative, and would probably be achieved by increasing parts density within housings.

Previously, development of electronic circuitry had always preceded any attention to appearance, packaging or human engineering. The electronic design group itself proposed the procedure followed this time—explorations with the Spilman staff of operating requirements and various packaging possibilities.

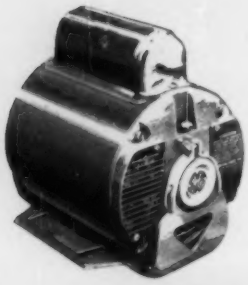
As soon as breadboard circuitry was developed, mechanical engineering personnel came in. Then, with completion of prototype circuits and mechanical systems, the industrial designers again took part.

Joint evaluation now indicated need for further size reduction, so a thorough analysis was made of what had to be on operating and connection panels. Schematics of the circuitry were re-worked. Result: parts density was increased, permitting lower units height. Necessary redistribution of current loads on lead-in wires gave an unexpected bonus—reduction of signal loss.

Approaches new to appearance design of data-processing panels were achieved, as well as the first integral hand grip (sketch, opposite page) in this type of equipment.

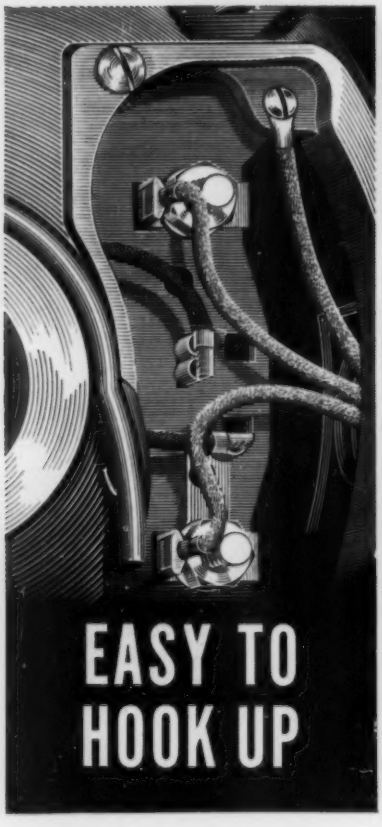


As sequence of illustrations at right indicate, data integrator made by PDP Div., American Electronics, Inc. Brooklyn, originally was two separate units: one for taking fixed data from punched cards and variable data via keyboard; the other, a tape punch unit for data storage. These components were customarily sold for desktop use, so the first sketches submitted by Design Analysts, New York, showed only desk models. But a switch to a free-standing floor design was recommended, so that keyboard height could be preset to optimum level for operator comfort and visibility. Cardboard model was approved and prototype built. Only standard sheet metal forming tools are required.



6 Reasons why

REDUCE

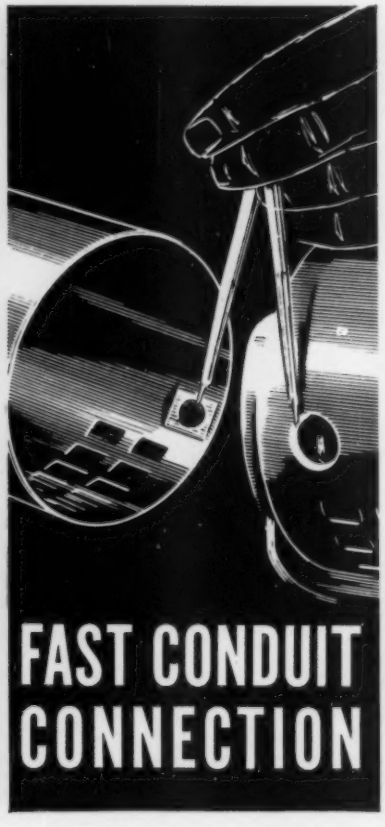


EASY TO HOOK UP

This enlarged wiring compartment saves hook-up time on the assembly line

Wiring compartments on G-E motors are now roomier and easier to work with. An enlarged opening allows greater accessibility. A narrower terminal board makes it easy to bring in leads from conduit. There are no extra studs on the board to result in "hook-up confusion." Easier, more accurate wiring results. How much can this extra value save you?

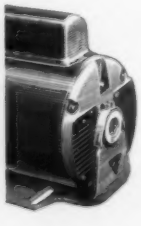
GENERAL ELECTRIC



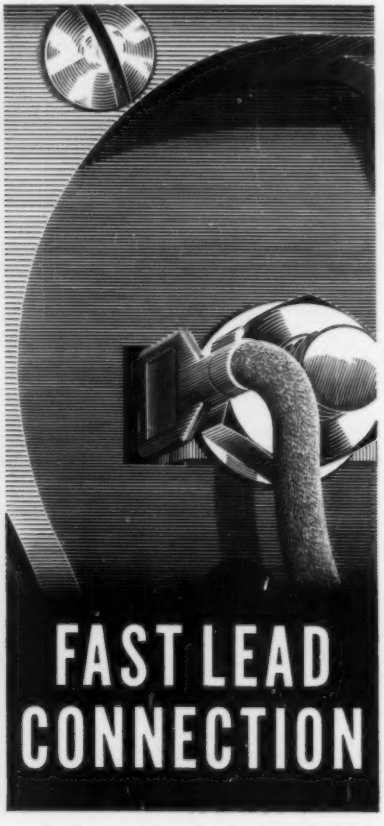
FAST CONDUIT CONNECTION

Special speed nut permits conduit connection from outside; cuts connection time 50%

Conduit connection is greatly simplified by single-thread speed nut welded inside the motor shell. This feature permits connection of conduit from outside the motor in half the time normally required with conventional lock nut. No waste of time fumbling with a loose nut, no possibility of dropping it in the motor or on the floor. It's a real time saver!



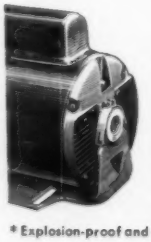
GENERAL ELECTRIC



FAST LEAD CONNECTION

Now plug-in connectors on all terminals cut wiring time in half

For the first time on all single-phase Form G motors, General Electric offers time-saving quick connectors on *all* external and internal contacts.* Wiring time is cut in half. (Studs have been retained for conventional wiring.) Simply plug in the leads. Fast, positive connections are assured. Try it yourself. You'll like this new General Electric extra value.



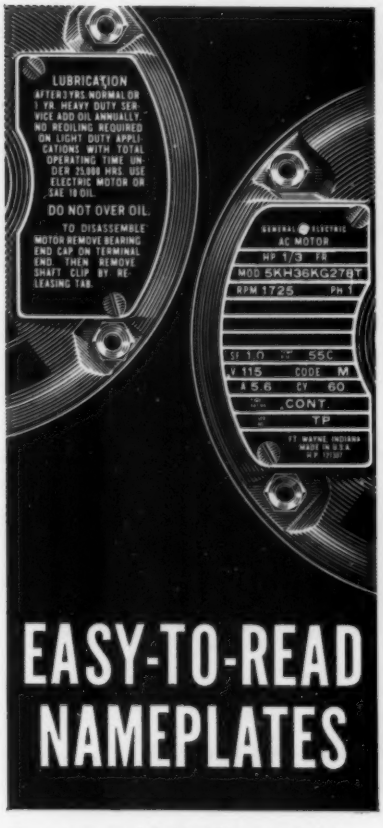
* Explosion-proof and a few special motors excepted.

GENERAL ELECTRIC

JUST ASK YOUR GENERAL ELECTRIC SALES ENGINEER

General Electric Form G motors . . .

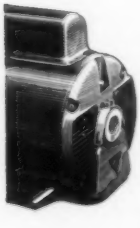
ASSEMBLY TIME

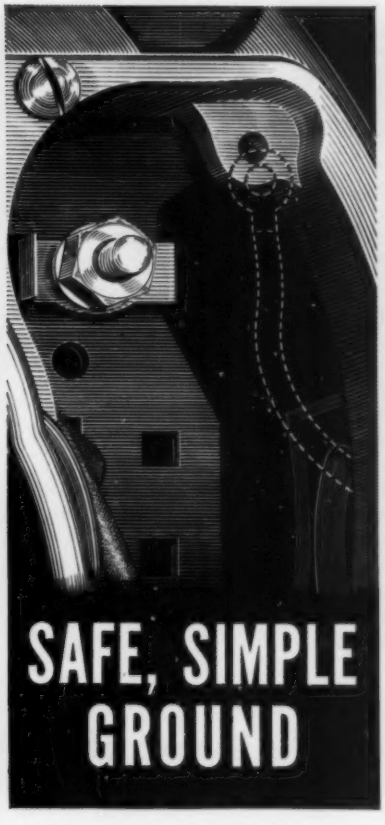

LUBRICATION
AFTER 3 YRS. NORMAL OR 1 YR. HEAVY DUTY SERVICE ADD OIL ANNUALLY. NO REOILING REQUIRED ON LIGHT DUTY APPLICATIONS WITH TOTAL OPERATING TIME UNDER 25,000 HRS. USE ELECTRIC MOTOR OR SAE 10 OIL.
DO NOT OVER OIL.
TO DISASSEMBLE MOTOR REMOVE BEARING END CAP ON TERMINAL END. THEN REMOVE SHAFT CLIP BY RELEASING TAB.
GENERAL ELECTRIC
AC MOTOR
HP 1/3 FR
MOD 5KH36KG278T
RPM 1725 PH 1
SF 1.0 55C
V 115 CODE M
A 5.6 CY 60
CONT
TP
FT. WAYNE, INDIANA
MADE IN U.S.A.

EASY-TO-READ NAMEPLATES

New permanent instructions and data simplify installation and servicing

Operating data on Form G motors is both legible and permanent to help you select, install and service without guesswork. The nameplate is engraved, then paint-filled for extra readability. Oiling instructions are lithographed on the terminal box cover plate. Lets your customers know exactly how *little* maintenance is required. *See* this extra value!





SAFE, SIMPLE GROUND

Built-in grounding lug permits fast, easy grounding to meet UL standards

Now on Form G motors you get a built-in grounding lug that meets UL standards for grounded third lead when required. With a self-forming screw you can make ground connections quickly, easily and inexpensively. This feature assures safe, permanent grounds. There's no chance of disconnection during maintenance. Ask for details on this extra value.

COMPACT, LIGHTWEIGHT

Small, light Form Gs easy to assemble; cut handling and shipping costs

Up to 50 per cent lighter, 40 per cent smaller than old-style designs, General Electric Form Gs are easier to handle, faster to install. Compact motor requires less mounting space and material; cuts down "assembly-line fatigue" caused by heavier motors; reduces stock space and shipping costs. You can't help but *save* with compact, lightweight Form Gs!

702-90

GENERAL ELECTRIC GENERAL ELECTRIC GENERAL ELECTRIC

ABOUT THE NEW FORM G "EXTRA VALUE" FEATURES

POINTS OF

The Question:

"To What Extent Does Motivation Research Affect Your Product's Design?"

"With ever-increasing competition . . .

for customers' dollars, it becomes more than ever essential to be aware of the customer's psychological preferences in order to design saleability into the product.

"Color, shape, size and weight are the most obvious preferences that cause the customer to choose one brand instead of another. These are usually more difficult to decide on properly than the basic mechanical features. Our most reliable information comes from properly conducted market research. If tests are conducted in an unbiased manner among a sufficient number of persons for whom the product was developed, resulting information is usually more significant than the opinion of one or more experts. Colors for our 'Stanley-Handyman' line of tools were selected by market-testing several recommended combinations, and the validity of the tests has been proved by ever-increasing sales of this line.

"Even sound is important. In our new garden-tool line, the hedge shears all have a shearing sound of scissors such as you hear in the barber shop. They 'sound' like they will cut well when a potential customer tries them, and they do because of the precision forming and grinding. Odd as it may seem, we also found that when judging weight, the customer is psychologically affected by color more than by a difference in volume of metal. Dark blades were 'too heavy' while light-colored blades felt light in weight."

R F WEST
Director of Product Engineering,
Stanley Tool Div. of The Stanley Works
New Britain, Conn.

"The findings of Motivation Research . . .

are used as production tools truly as much as the presses of the production lines. MR is continually used in the orderly sequence of steps leading to the product that is destined to be mass-produced, and mass-consumed. Planning, creating, formulation and production MR is relied on by the industrial designer, the engineer, the tooling and production men. It is a vital factor in advertising and promotion, and its findings play an important role in sales and distribution.

"The What? Where? How? and When? product pattern are established with help from MR. Our design staff refers to MR continuously to help define consumer preference with reasoned direction. Portable appliances in particular are sensitive to a more comprehensive refinement of industrial design effort. Being portable, they are more likely to be entities in themselves, as a steam iron, vacuum cleaner, mixer, percolator, etc. They must also stand very close personal inspection and scrutiny, i.e. the 'bottom' surface of a fry pan, the base of a percolator, the unity of a blanket control. Since they are personal and intimate, the visual and tactile qualities are more demanding; as an example, the handles must be comfortable and functionally correct for the majority of users. The consideration of the user's position—sitting, standing, walking, etc.—left-handed and right-handed usage, and a multitude of other considerations must be determined prior to mass production.

"MR 'points up' consumers' likes and dislikes. The blind approach is negated, and the chances for a successful product are enhanced."

F W PERL
Director of Styling
Electric Appliance Div
Westinghouse Electric Corp

VIEW

"It is time we made a distinction . . .

between 'motivation research' and 'manipulation research.' In the former, you attempt to determine how your customers think and what factors are important to them in purchasing the type of product you manufacture. Then, with this knowledge as a guide, you design your new products so that they incorporate as many as possible of the features of appearance, convenience and operation that are important to your customers.

"'Manipulation research,' on the other hand, attempts to determine the factors that motivate the purchaser so that this information can be incorporated into advertising and sales efforts with little or no real change in the products. In other words, this is the application of the same MR techniques to discover the weaknesses of your customers rather than to strengthen the design of your products.

"We are concerned with motivation research of the first type and achieve it by two methods. The improvement of machines which already exist is greatly influenced by a tight feedback loop between the customer and ourselves. We are fully aware that what he wants is not so much a machine as the productivity of the customer's installation. This, with the customer's comments and suggestions, is fed to a service control center where the status and productivity of all machines throughout the world is displayed on control boards. As regards new machines, we use logical deduction and a concentration on understanding the needs of a few representative customers. For us this is a much faster, less expensive and more accurate method than board surveys involving masses of data. Our business is data reduction. Very often the best way to reduce a mass of data is not to have collected it in the first place."

BERNARD S BENSON
President
Benson-Lehner Corp

"There are certain limitations . . .

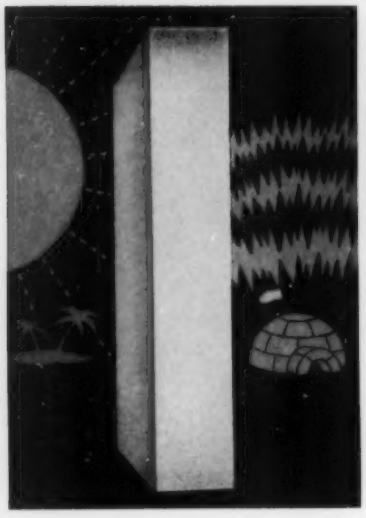
in connecting any consumer surveys—certain things that we cannot hope to find out with any degree of accuracy or dependability. In our case we consider the average car owner as an expert on the USE of the product, and it is in that area that we seek his opinions. Such information can be obtained, up to a point, by indirection. By getting a measure of the features, types of design, etc., that are best liked at the present, it is possible for our stylists, engineers and technicians to work along lines most likely to prove popular in the future. It is still the job of our stylists and technical people to do the forward looking, and to conceive the new ideas which annually add to the value of cars and the enjoyment of driving.

"Our surveys are not confined to the product itself. We make periodic studies of owners' opinions regarding service offered by car dealers. Sometimes we survey the dealers themselves on general business conditions and various other subjects of mutual interest. We try to delve into such things as what actually happens when a person buys a car: who decides what make and body model it shall be; why he chose the car he did rather than some other make; how was he treated by the salesman, how would he like to have been treated, etc.

"Naturally we can't hope to get the final answer to any of these things, because people are unaware of, or unwilling to admit, some of the factors that influence them, and because public tastes are constantly changing. But to the extent that we can find out what they like, to that extent we can do a better job of giving people what they want—and incidentally, make it that much easier to sell the products we make."

MARSDEN THOMPSON
Director, Customer Research Staff
General Motors Corp

FIVE REASONS WHY
IS THE BEST ANSWER



DYLITE IS AN INSULATOR

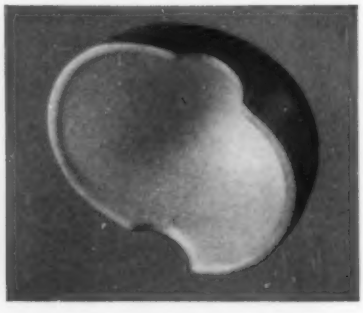
The Thermal Conductivity (K Factor) of DYLITE is 0.242 at a 75°F. mean temperature at 2 lb./cu. ft. density. DYLITE is highly resistant to the passage of heat and is unaffected by moisture condensate. DYLITE is easily molded to fit the contours of component parts of refrigerators, air conditioners and freezer cabinets.

DYLITE IS WATERPROOF

At 2 lb./cu. ft. density, DYLITE's rate of Water Vapor Transmission is 1 18 perms., and its rate of Water Absorption is 0.54 lbs./cu. ft. after 48 hrs. immersion. DYLITE is ideal for boats, rafts, buoys and other types of buoyant marine equipment. DYLITE remains in the water indefinitely without becoming waterlogged, and it is mildew-proof.

DYLITE IS SHOCK-RESISTANT

DYLITE possesses an Energy Absorption ratio (Maximum Load) of 56.74 in. lbs./cu. in. at a density of 2 lb./cu. ft. For example, police safety helmets with shock-absorbent DYLITE liners are now used extensively—a result of performance tests in which DYLITE was proved superior to other materials for this job.



Typical Properties of DYLITE—Density 2 Lb./Cu. Ft.

- Compressive Strength—30 Psi
- Tensile Strength—55 Psi
- Water Vapor Transmission—1.18 Perms.
- Water Absorption—0.54 Lbs./Cu. Ft. After 48 Hrs. Immersion
- Thermal Conductivity (K Factor)—0.242 at a 75°F. Mean Temperature
- Energy Absorption (Maximum Load)—56.74 In. Lbs./Cu. In.

DYLITE is a registered trademark of Koppers Company, Inc.

DYLITE

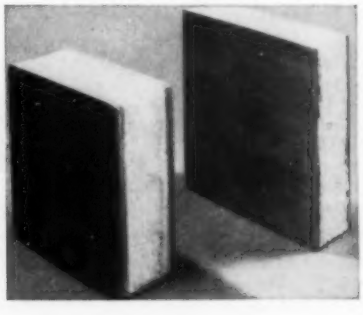
TO YOUR DESIGN PROBLEMS

DYLITE IS LIGHTWEIGHT

DYLITE is lighter than cork—it can be molded in densities of 1 to 10 lb./cu. ft. The advantages of light weight are obvious. In packaging, DYLITE helps reduce shipping costs and makes handling easier. In the construction field, where DYLITE is used as an insulator, its light weight means fast and easy installation.

DYLITE IS STRONG

DYLITE has a Compressive Strengtn of 30 psi and a Tensile Strength of 55 psi at a 2 lb./cu. ft. density. DYLITE can be used to great advantage in a wide variety of industrial design problems. For instance, sandwich structures that employ DYLITE as the core material offer high strength without sacrificing light weight.



KOPPERS

Offices in Principal Cities: In Canada: Dominion Anilines and Chemicals Ltd., Toronto, Ontario

KOPPERS PLASTICS

DYLITE

Koppers Company, Inc.
Plastics Division
Dept. PE-1269
Pittsburgh 19, Pennsylvania

☐ Please send me more information on DYLITE expandable polystyrene.

☐ Please have Koppers representative call.

☐ I'd like more information on DYLITE concerning possible application in_____

Name

Firm

Address

City

State

SIGNIFICANT COMPONENTS MATERIALS PROCESSES

Contoured photovoltaic cells . . .

are pliable, specially processed photocells that can be shaped into almost any form, can be mounted on stationary, rotating or reciprocal machine elements or may be used as a form of nonlinear function generator when formed into a photosensitive cam. Cells can be produced to any requirement in 3-dimensional shapes with as little as 1 in. radius of curvature, ¼ x ¼ in. min to 10 x 10 in. max. Consists of a metal base, on which are deposited layers of selenium, cadmium and gold; then treated to be light-sensitive. Upon exposure to light, cell generates about ½ v power. Cells are made to specifications. Delivery, 2 to 3 wk. **International Rectifier Corp, 1521 E Grand Ave, El Segundo, Calif.**

Circle 11 Reader Service Card

Magnet-actuated switch . . .

detects very small amount of mechanical motion and is actuated by $\frac{1}{16}$ oz moving Alnico magnet. Operates in any position. SPST switch is filled with hydrogen and hermetically sealed in glass to eliminate contact contamination. Rated 125 v ac, $\frac{1}{16}$ amp, but is available in larger sizes and ratings. Operates under high and low pressures over temperature range, —85 to 350 F. Contains no liquid or vapor and may be used in explosive or corrosive atmospheres. Laboratory tests are said to indicate trouble-free operation in excess of 10 million, at 60 per sec max. Unit is 1⅛ x ¼ in. dia. $3 each, list. From stock. **Hamlin Inc, 1316 Sherman Ave, Evanston, Ill.**

Circle 12, Reader Service Card

Nuclear batteries . . .

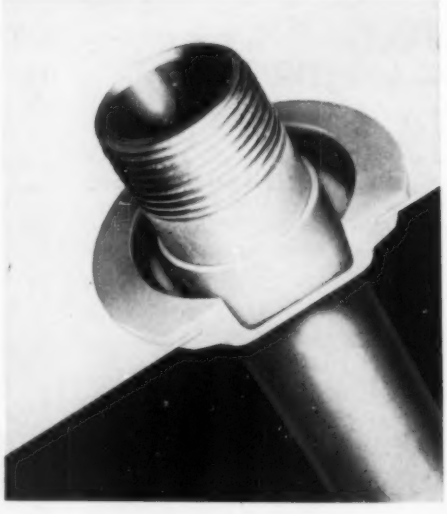
use krypton isotope to produce output potentials greater than 5 kv in a volume less than ¼ of 1 cu in., and are said to be free from radiological ingestion hazard in shielded state. If a battery is accidentally open, krypton dissipates harmlessly into atmosphere. Operation of batteries is based on principle that beta particles penetrating solid dielectric are collected as electrical energy. Operates in temperatures of —175 to 165 F. Metal can is ¼ in. dia x 1 in. long, with axially projecting terminal. Weighs 1 oz. Useful life, limited by the half-life of krypton 85, is about 10 years. AEC authorization is necessary for purchase. Introductory price for developmental model is about $95; volume price is expected to be under $5. From stock. **Radiation Research Corp, 1114 First Ave, New York 21.**

Circle 13, Reader Service Card

High freeze-thaw resistance . . .

is offered in sealing compound said to have outlasted conventional sealing materials by 200:1 in controlled laboratory tests. Material is described as nonoxidizing, permanently plastic, nontoxic, odorless, nonstaining on plastics, refrigerator enamels and porcelain, resistant to food acids, noncorrosive to metal, and not affecting rubber. Will not flow from —40 to 400 F and will not become brittle at —40 F. Adhesion and cohesion to all types of clean surfaces, similar and dissimilar, makes sealer suitable for preventing passage of water or water vapor, sealing fasteners in doors where low temperatures are encountered, sealing entry of refrigerant tubes and wiring into inner liner, or refrigerant lines into outer cabinet. **Presstite-Keystone Engineering Products Co, 39th and Chouteau, St. Louis.**

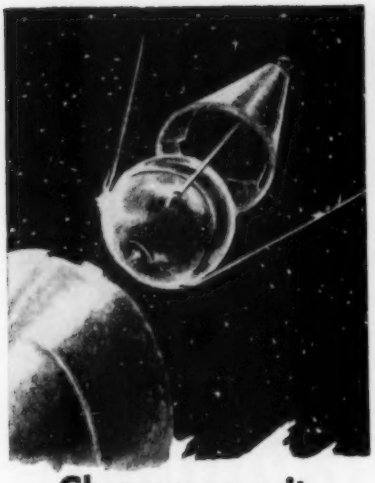
Circle 14, Reader Service Card



Flexible vinyl grommet . . .

for low-pressure sealing applications where piping, conduit or shaft passes through panel as thick as 0.074 in. Snaps into place, self-positioning and self-sealing. Said to resist most chemicals and acids and not to transmit vibration. Accommodates off-center piping, allowing greater manufacturing tolerances. For temperatures from —25 to 250 F. Available units cover popular tube and pipe sizes from $\frac{7}{8}$ to 3⅝-in. tubing and ½ to 3-in. pipe. Stocked in red only. Price per 100, delivered, ranges from about $18 to $27, according to size. **LMR Engineering Corp, Clayton PO Box 106, St Louis 5.**

Circle 15, Reader Service Card

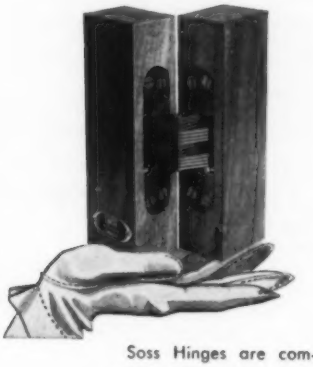


Chances are it will be equipped with—SOSS INVISIBLE HINGES

"The Hinge That Hides Itself"

Soss Invisible Hinges enable you to do a better job whether you're designing a rocket to the moon or a new typewriter.

NO PROTRUDING HINGE BUTT



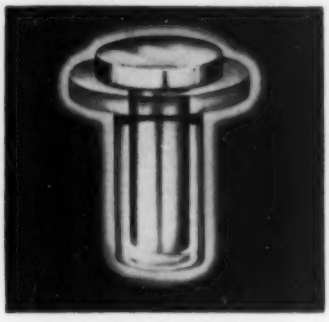
Soss Hinges are completely hidden from view when doors or lids are closed. They are the only hinge that creates the flush, smooth streamlined surfaces so necessary for modern design. Unique Soss Hinges are available in a wide size range to meet every requirement.*

For complete details, prices and free illustrated catalogue, write today to:

SOSS MANUFACTURING COMPANY
Department PER-1, P. O. Box 38
Harper Station, Detroit 13, Michigan

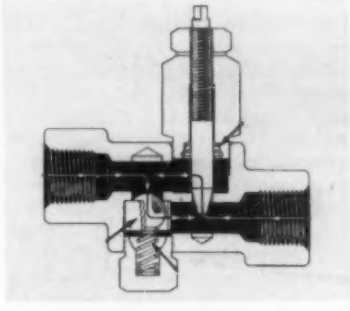
CIRCLE 70 READER SERVICE CARD

SIGNIFICANT COMPONENTS MATERIALS PROCESSES . . .



Plastic-insulated rivets . . . are aluminum, brass, steel or other metal with shank and under-head surfaces covered with uniformly thick nylon, which extends slightly beyond rivet head circumference and also beyond end of rivet. Used to fasten two or more electrically conductive metal parts and also for riveting to ceramic or glass, where nylon acts as a shock absorber. New method of manufacture is said to make possible many new sizes previously unavailable and to permit lower prices in production quantities. **Pylon Co Inc, Attleboro, Mass.**

Circle 16, Reader Service Card



Oversize ports, passages . . . in line of flow-control valves, with forged aluminum bodies, are said to provide optimum control and sensitivity in control of hydraulic or air cylinders. Specifically designed for oil and air service to 3000 psi, valves are also suitable for hydraulic circuits, where max flow achieves greatest efficiency. Flow adjustments under full-rated pressures are said to be possible because of a compensating pressure gland that permits self-alignment without leakage or abnormal wear. Sensitive check valve permits full flow in one direction; tapered pointed vernier thread needle provides flow adjustments in opposite direction. In three models: standard $\frac{1}{8}$, $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, and $\frac{3}{4}$-in. pipe sizes. **Auto-Ponents, 3001 Grant St, Bellwood, Ill.**

Circle 17, Reader Service Card

NEW DESIGN

data for **Pearlitic Malleable** in this NEW BOOK!

This 76-page handbook furnishes an introduction to pearlitic malleable as well as a ready reference to the latest information and data on pearlitic malleable obtained from many sources by the Malleable Research and Development Foundation.

Pearlitic malleable is a relatively new material in the metallurgical field, and its increasing application in castings for critically loaded structural parts in modern machines and other products of all kinds, testifies to its acceptance by quality-minded engineers. Pearlitic malleable has toughness and machinability at high strength levels and is relatively low in cost.

A new design approach to pearlitic malleable specifications is presented in three charts that show the relationship between physical properties and Brinell hardness. The charts furnish the information required to translate basic design needs into final specifications.

All the facts and figures needed for pearlitic malleable design are here in this handbook. Any person responsible for the specifying or selection of materials is invited to send coupon today for complimentary copy.

PE-1

MALLEABLE RESEARCH AND DEVELOPMENT FOUNDATION
Granville, Ohio

I can use the Modern PM Castings Handbook in my work. Please send copy to:

NAME _____

POSITION _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

CIRCLE 71 READER SERVICE CARD

mold reactor
fuel elements in
precision glass
New idea if you're in reactor fuel business. Elements injection cast in precision bore high silica glass tubes. Seventeen inches long. Precision shrunk by F&P to bore diameter of 0.1475 ± 0.0005 in. Absolutely straight, uniform. Interesting? Doesn't even scratch surface! Regularly hold bore to ± 0.0001 in., can go to ± 0.00005 in. Also control o.d., taper, concentricity, length . . . you name it. Almost makes glass new design material! More ideas, information Catalog 80-23. Write for copy, or send sketch. Fischer & Porter Co., 6119 County Line Road, Hatboro, Pennsylvania.
FP

SIGNIFICANT COMPONENTS MATERIALS PROCESSES . . .

Servo-type actuator . . . is for automatic operation of ball valves and other rotary stem valves, regardless of how remote or inaccessible the location. Installs on existing valves, in any position, without disturbing piping. Requires no air lines or air compressors. Explosion-proof, it can be used in hazardous locations. Available for ¼ to 8-in. valves. Each model is said to deliver many times torque required to operate valve for which it is rated. **R & A Machine Co Inc, 100 Grove St, Worcester 5, Mass.**

Circle 18, Reader Service Card

Positioning switch . . . for remote control of valves or damper motors eliminates lags between switch and actuator mechanism. The switch, 20% small than earlier models, permits compact flush or surface mounting on panel boards. Hysteresis has been eliminated by using a ball valve instead of needle valve in switch. Dimensions are 2⅜ x 3⅜ x 2¼ in. deep, including face plate. Available for flush or surface mounting. Body air connections are for ⅛ in. NPT. Flexible air hose has terminal connections for ¼-in. OD tube. **Powers Regulator Co, 3490 Oakton St, Skokie, Ill.**

Circle 19, Reader Service Card

Gas flowmeter . . . calibrated for true mass flow is electrically operated and UL-approved for use with Class I, group D flammable and explosive mixtures. Unit consists of gas-flow indicator and gas-flow probe. Probe is easy to install and electrically safe because voltage is limited to a fraction of a volt and current to a fraction of an amp. Resulting temperature rise on thermal elements under no conditions exceeds 87.8 F. Total quantity of gas flowing is measured directly. Indicator has linear scale from 0 to 200. Calibration curves are available for air over the range from 25 to 6000 fpm at STP or from 2 to 450 lb per min per sq

Write Dept P-159 for new Indium bulletin: "Determination of Arsenic in Indium Arsenic Alloys."

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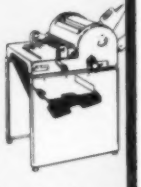

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ft of cross sectional area. Indicator, model FI-6, is $395; probe, type S-16-B, is $190. Delivery, 6 to 8 weeks. **Hastings-Raydist Inc, Hampton, Va.**

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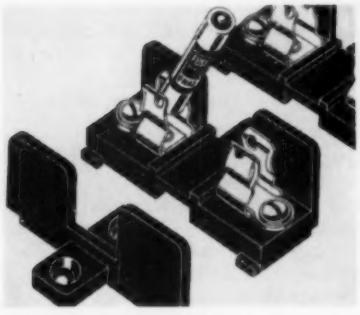

Add-on fuse blocks . . .

for protection of solenoids, small motors or control apparatus on multiple circuit equipment may be assembled into a unit fuse block of one or any number of poles. Single-pole blocks interlock by means of a boss that slips into recess in bottom side of adjacent block, locked by single screw. Poles may be added or removed without disconnecting terminal leads on other units. Clips permit raising one end of fuse to right-angle position. Simplifies identification of the open circuit. **Bussman Mfg Div, McGraw-Edison Co, University at Jefferson, St Louis 7.**

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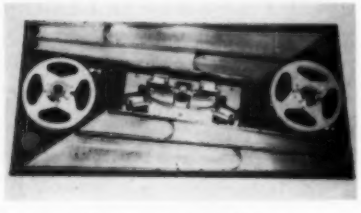

Magnetic tape machine . . .

has multiple vacuum loop that acts as slack loop between reels and reduces power necessary for servo reel drive. Also makes possible tape speed increase with constant servo power. Transistor-equipped model features character-transfer rates to 45 kc on ½-in. tape and 90 kc on 1-in. tape. Reel servo drives impose no limitations on block feed cycles with 10½-in. reels of 1-in. tape at 150 ips. **Potter Instrument Co, Sunnyside Blvd, Plainview, NY.**

Circle 22, Reader Service Card

Dc constant-speed motor . . .

is equipped with a governor said to control shaft speed variation within 1%. Motor is rated to 1/1000 hp at 4500 to 9000 rpm with a rotor torque of 3.5 in.-oz for intermittent duty. Rotation may be supplied clockwise or counterclockwise. Wide range of outputs is available with input

CONTINUED ON PAGE 48

10 to 100 times the wear resistance of other dry bearings

Comparative Thrust Washer† Performance

Type of Material	Mean Testing Time	Reason for Stopping
DU Composite	1000 hrs.	Completed 1000 hrs.
T.F.E. in porous Bronze	213 hrs.	.005" wear
Graphite & Lead Bronze	158 hrs.	.010" wear
T.F.E. + 25% Graphite	134 hrs.	.005" wear
Oil impregnated Bronze	105 hrs.	.010" wear
Phenolic resin + MoS_2	73 hrs.	.005" wear
T.F.E. + 25% Glass fibre	48 hrs.	.005" wear
MoS_2 Treated Steel	26 hrs.	Seizure
Graphite (bearing grade)	24 hrs.	.005" wear
Porous Bronze + MoS_2	17 hrs.	.005" wear
Asbestos + resin + MoS_2	0.8 hrs.	.005" wear
Nylon	0.3 hrs.	.010" wear

†*Thrust Washers used for comparative tests as most indicative of true relationship of values, since clearances do not enter into their performance.*

Compare performance and you will agree that DU—the patented steel-backed porous-bronze bearing with T.F.E.* fluorocarbon resin-lead—offers an entirely new conception of dry bearing service.

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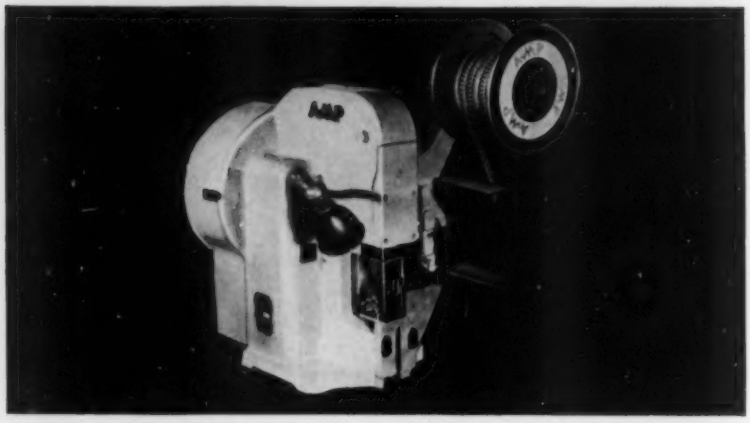

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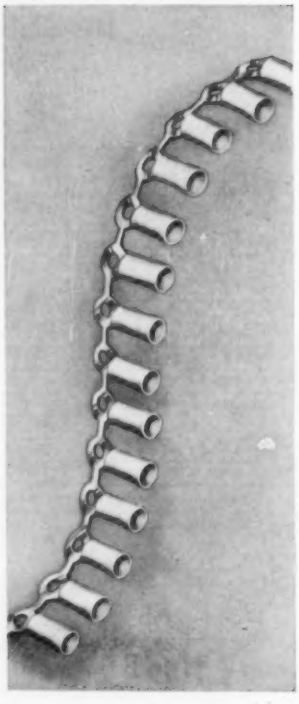

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General Offices: Harrisburg, Pennsylvania

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CONTINUED FROM PAGE 47

voltages from 24 to 48 v dc. Shaft diameters range from 0.109 to 0.118 in. Stud mountings are for 4-40 thread. Sealed ball bearings require no lubrication. Overall dimensions are approximately 1½ x 3 in., including shaft that protrudes about ½ in. beyond motor frame. Weighs about 7 oz. **Carter Motor Co, 2773-A W George St, Chicago 18.**

Circle 23, Reader Service Card

Pushbutton and pilot light . . . combination results in illuminated oiltight unit for heavy-duty applications. Contact blocks have double break, normally open-normally closed contacts of silver alloy. Flexible circuitry permits pilot lamp to be wired to go on or off when button is pressed, or it can be energized from a separate source. Unit can also be wired as a push-to-test pilot light and normal pilot light lenses are available for this type of service. Step-down transformer is built into each unit to supply 6-v pilot lamps. Lenses can be furnished in a variety of colors. Guard collars are available to protect button and may be used with a padlock to lock button in down position. **Allen-Bradley Co, 136 W Greenfield Ave, Milwaukee 4.**

Circle 24, Reader Service Card

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NEW LITERATURE

Management's Stake in Research

***MAURICE HOLLAND** and contributors. Harper & Brothers, New York City. 5½ x 8½, 143 pp. $3.50.*

What should management expect of research? Maurice Holland's answer is that it depends on the research needs of the kind of industry managed. But the best way to find out what it should expect is to find out what it does expect. In a survey of the presidents of a variety of industrial concerns in the US, the six most frequent answers were, in order: new products; maintenance of competitive technical position; cutting of production costs; sales volume and net profits on new processes and products; new and improved processes to increase production; and informed assistance in long-range planning.

This book covers all the phases of research that would be of interest to management. Not a how-to-do-it manual; it is, rather, report on how it's being done. It is designed to answer many of the questions top managements are asking, not by rule-of-thumb precept, but by example. Some of the subjects covered are: management's role in research; what it should expect of research; gearing research to markets; should small companies farm out research or do it themselves; how much to spend; financing the results of research.

Recognizing that no man is wise enough, out of his own knowledge, to do full justice to so complex a subject as industrial research has become, Holland asked a number of distinguished contributors to supplement his own work. For example, the chapter on "Inventions, Research and Creativity" is co-authored by Dr Lawrence Hofstad, vice-president in charge of research of General Motors, and J D Porsche of Armour & Co; the chapter on "Financing the Results of Research" by Ferdinand Eberstadt, senior partner, F Eberstadt & Co; the section on "Five Measurements of Research Performance" by E Duer Reeves, executive vice-president of Esso Research and Engineering Co; and "A Bow to Basic Science" by J E Hobson, Director of the Stanford Research Institute. PNA

HIGH-CAPACITY V-BELT DRIVES—Catalog DH-900, 26 pp. Covers drive designs utilizing V-belts in three new cross-sections and new line of sheaves. Drives offer more hp per in. of face width. Includes specifications, operating characteristics, ratings, selection tables, dimensional diagrams and cross-sectional views. Gates Rubber Co, Denver.

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WROUGHT COPPER AND COPPER-BASE ALLOYS—Brochure, 10 pp. Lists properties, forms and composition of wrought copper and copper-base alloys available. Western Brass Sales, Metals Div, Olin Mathieson Chemical Corp, East Alton, Ill.

Circle 3, Reader Service Card

POWER LUBRICATION SYSTEMS—Catalog 81, 32 pp. Includes descriptions of automatic centralized systems, semi-automatic and manual methods of lubricating machines, fittings and accessories. Give specifications, dimensions. Lincoln Engineering Co, 5737 Natural Bridge Ave, St. Louis 20.

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HIGH-PURITY TANTALUM—Technical folder, 4 pp. Describes application of material to electronic, nuclear, chemical and missile industries. Discusses available forms and gives exact chemical analysis and mechanical and physical properties. National Research Corp, 70 Memorial Dr, Cambridge 42, Mass.

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NATIONAL STANDARD FASTENERS—Bulletin 2460, 4 pp. More than 70 different fasteners normally specified are identified with front- and side-view sketches and type indication. Source of each is listed and, in many instances, min tensile or shear strengths. Box 545, Standard Pressed Steel Co, Jenkintown, Penna.

Circle 6, Reader Service Card

ALUMINUM FORGING FACILITIES—Brochure, 36 pp. Discusses in three illustrated sections, equipment, products and services of Alcoa plants. Aluminum Co of America, 1501 Alcoa Bldg, Pittsburgh 19.

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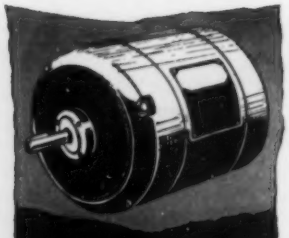

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Publisher's Postscript...

The RESPONSE was more than we expected.

In our Publisher's Postcript in the Dec 15 issue, we asked for your opinion on the value of perforations at the binding edge of editorial and advertising pages of Design issues, for easy removal and filing. We expected to receive a reasonable response that would help the editors get a "feel" of the desires of our readers.

Looks like we walked right into the lion's mouth. What a roar of response! In just a little over three weeks since its publication, almost 1,300 readers have sent us their ideas. If the response had just been a simple "yes" and "no," we could easily accept the result that 88% wanted perforated pages, and 12% were against the idea. While your votes are still coming in, in good numbers every day, the ratio of over 7 to 1 hasn't changed. But it wasn't just a simple "yes" and "no" vote. Many readers wrote interesting letters on how they save and file *Product Engineering* articles and advertisements. Many sent constructive suggestions on how we might render a more useful service. A few made recommendations that fall outside the realm of good business paper publishing practice—but they all were helpful. The negative vote was mostly from librarians.

Excellent ideas which appeal to us quite strongly were submitted, but some of them will require more study with respect to postal regulations and production problems as well. We are not going to rush into perforating pages immediately, but you can be sure that your ideas are getting serious thought, and one of these days before too many issues pass, we'll be reporting to you again.

May we express our sincere thanks to you for your fine and helpful cooperation. As you well know we are publishing this weekly for you, and we want to leave no stone unturned in making it more and more interesting and useful to you.

Incidentally, in our last Postscript (Jan 12, '59, p 50), we mentioned that the new *Product Engineering* Editorial Index—covering both the Design and the R&D issues for the last 6 months is ready. It's free. If you didn't order a copy just write "INDEX-Vol. 29–2" on the Reader Service card on the facing page in the place marked "Special Data," sign your name and address, and it will be mailed to you promptly. Some copies of the Index for the first 6 months of 1958 are still available. If you want one, just add "Vol. 29–1" and it will be sent along, as long as our supply lasts.

—AH

For Your Information (personal)

Colder facts about the cold

How cold is a "chilling wind"? The Army decided to find out—and found it's plenty cold. Here, to guide your own plans for outdoor living (and outdoor products) is a portion of the "Wind Chill Chart" developed by Army medical researchers. To use it, find the expected wind velocity, and move down that column until the temperature closest to the expected figure is reached. From that point, move horizontally all the way to the right—to the point where your horizontal intersects the "0" wind-velocity column. That gives the equivalent or effective temperature. For example, suppose the wind velocity is 20 mph, and the expected temperature is 35 F. Going down the "20" column, 34 is the closest temperature figure. Following its horizontal to the right, gives an equivalent reading of —38 F. Without protection then, you'll feel 73 degrees worse than the thermometer said.

Temperature, °F	Wind Velocity (miles per hour)					
	25	20	15	10	5	0
	80.5	80	79.5	78	76	60
	69.5	68	67	65	60	23
	59	57	55	52	44.5	—11
	47	45	42.5	38	28	—27
	36	34	30.5	25	11	—38
	25	23	18	11	—5	—40

And don't go near the water

Not to be outdone by the Army, Navy has come up with a table showing that cold water is no health-cure either. Even at 50 F, Navy researchers say, "death from immersion . . . has been reported to occur within a very few minutes." At 40 F, a man who is not wearing watertight clothing can survive less than 3 hr; and at 32 F less than 1 hr, even under best conditions. Actual survival times may be less than 1/5 of those figures. Only when water temperature goes above 70 F can survival be measured in days rather than hours or minutes.

New coats: from cars to houses

The acrylic emulsion finishes that sparked so much interest when they were introduced on 1959 cars (*PE*—Sep 15, '58, p 37) will soon be simplifying house-painting for the do-it-yourselfer, and providing a better, longer lasting finish. DuPont chemists say coatings that can be applied by brush or roller, will air-dry in less than an hour, and "are capable of providing unprecedented protection against blistering," will soon be available commercially in white and several colors. The coatings need a special primer; and as yet, are recommended only for use on new or thoroughly cleaned wood; but DuPont says tests so far indicate they'll also do quite well when applied over old finishes if the base is still firmly adherent.

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Why Don't They R and D ...

. . . a better means of bringing power to house and office electrical equipment. Lamps, radios, adding machines and TV sets make a snake pit of wires that are unsightly and a fire hazard as well. The Russians talk about electric buses and trucks with power transmission by high-frequency fields (*PE*—Dec 29 '58, p 26). A similar system might be used in desks or floors. Or how about making desktops with contact grids embedded in a rubber-like material that would be pierced by sharp spikes in the underside of adding machines, etc.? —B W Hausman

. . . a standard set of lights or indicators for the rear of automobiles so that a person with normal vision could estimate his distance from their appearance. If the lights were arranged as shown here they could be dimensioned to appear as a single rod at 600 ft, as a pair of rods at 300 ft, as a double pair at 150 ft and as four pair at 75 ft. —E R Layman

. . . an inexpensive microphone and circuit that would recognize simple commands. Owner-adjusted to throw a relay at the spoken words ON and OFF, or LIGHT and DARK, the built-in circuit would react to the pattern of sound—not its absolute pitch or volume. Much is now being done in the analysis of spoken words for so-called "voice writers" to ultimately replace stenographers, but most of us would be happy with the less ambitious, more immediately practical gadget to turn lights and TV commercials on and off with a word. —R Myram

Have you a pet subject but neither the time nor inclination to do the necessary R & D? Product Engineering will welcome (and pay $10 each for) similar ideas based on known scientific principles but lacking an inspired manufacturer

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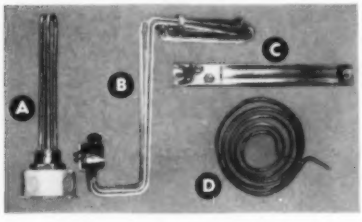
Liquid Heating Guide

How to choose electric heaters for liquid heating applications

Here is condensed information to help you get the most economical electric heaters for your liquid heating design problem.

Three factors generally determine which type heater should be used for any particular liquid-heating application. They are: the physical characteristics of the container, the nature of the liquid, and the temperature requirements.



General Electric "screw-in" immersion heaters (a) have threaded headers, which make for easy and permanent installation in pipes, tanks and vessels. "Over-the-side" immersion heaters (b) hang in tanks or containers, and besides being portable, they are ideally suited for heating rubber-lined tanks, lead-lined tanks, tanks of wood, slate, and other materials which are not adaptable to heaters with threaded headers.

Because some metals are subject to attack when immersed in certain liquids, G-E heaters are made in a variety of sheath materials so that they can be used for a wide range of liquids. Sheath materials of copper, steel, stainless steel, nickel, nickel-plated copper, nickel-silver, Inconel, Monel, cast iron and lead are all available.

General Electric heaters are ideally suited to heating a wide range of liquids: Water, oil, electroplating baths, cleaning compounds, chemical baths, and other fluids. These liquids can be circulating or non-circulating; in open containers, closed or pressure, vessels, kettles, or steam generators. Heavy viscous liquids, such as pitch, molasses, and asphalt can be heated by using a liquid jacket containing immersion heaters.

Where extremely corrosive liquids are to be heated, it is also often best to use a water jacket around the tank. Immersion heaters may be used for water heating in this type of application. Many times, it is easier to clamp strip heaters (c) or tubular heaters (d) to the side of the tank.

TABLE I—Water, Alkaline or Plating Baths

Amount of Liquid		Degrees F Temperature Rise						
Cubic Feet	Gallons	20	40	60	80	100	120	140
		Kilowatts to Heat in One Hour						
.66	5	0.3	0.5	0.8	1.2	1.6	2	2.7
1.3	10	0.5	1.1	1.6	2.4	3.2	4	5.3
2.0	13	0.8	1.6	2.4	3.6	4.5	5.7	7.2
2.7	20	1.1	2.2	3.2	4.8	6	7.5	9.5
3.3	25	1.3	2.7	4	6	7.5	9.5	12
4.0	30	1.6	3.2	4.8	7	8.8	11	14
4.7	35	1.9	3.7	5.6	8	10	13	16
5.3	40	2	4	6	9	12	15	20
6.0	45	2.4	5	7	11	14	18	23
6.7	50	2.7	5.4	8	12	15	19	24
7.4	55	3	6	9	13	16	20	25
8.0	60	3.3	6.4	9.6	14.5	18	23	29
8.7	65	3.5	7	10	15.5	19.5	25	31
9.4	70	3.7	7.5	11	17	21	26	33
10	75	4	8	12	18	23	29	37
10.7	80	4.3	8.5	13	19	24	30	38
11.4	85	4.5	9	13.5	20	25	31	39
12.0	90	5	10	14.5	22	28	35	44
12.7	95	5	10	15	23	29	37	47
13.4	100	5.5	11	16	24	30	38	48
16.7	125	7	13	20	30	38	48	60
20.0	150	8	16	24	36	45	57	72
23.4	175	9	18	28	42	53	67	85
26.7	200	11	21	32	48	60	75	95
33.7	250	13	27	40	60	75	95	120
40	300	16	32	47	70	88	110	140
46.8	350	19	37	56	83	105	130	165
53.4	400	21	43	64	96	120	150	190
60.1	450	24	48	72	107	135	170	214
66.8	500	27	53	80	120	150	190	240
Maximum Time (hours)		**10**	**10**	**7**	**5½**	**5**	**4**	**3½**

TABLE II—Use This Table For Oil

Amount of Oil To Be Heated		Degrees F Temperature Rise					
Cubic Feet	Gallons	50	100	200	300	400	500
		Kilowatts to Heat in One Hour					
.5	3.7	.3	.5	1	2	2	3
1	7.4	.5	1	2	3	4	6
2	14.9	1	2	4	6	8	11
3	22.2	2	3	6	9	12	16
4	29.9	2	4	8	12	16	22
5	37.4	2	4	9	15	20	26
10	74.8	5	9	18	29	40	52
15	112.5	7	14	28	44	60	77
20	149.6	9	18	37	58	80	102
25	187.	11	22	46	72	100	127
30	222.5	13	27	56	86	120	151
35	262.	16	31	65	100	139	176
40	299.	18	36	74	115	158	201
45	336.5	20	40	84	129	178	226
50	374.	22	45	93	144	197	252
55	412.	25	49	102	158	217	276
60	449.	27	54	112	172	236	302
65	486.	29	58	121	186	255	326
70	524.	32	62	130	200	275	350
75	562.	34	67	140	215	294	375
Maximum Time (hours)		**10**	**10**	**8**	**7**	**6**	**5**

To figure the amount of heat required for your application:

1. Find the number of gallons or cubic feet of liquid to be heated.

2. Figure needed temperature rise in degrees F. (Subtract initial temperature from needed temperature.)

3. Check either Table I or Table II from the nearest amount of liquid to the desired "temperature rise" in the right-hand column.

4. Add 4% to the figure you now have if there is no insulation on your container or tank.

5. Divide the answer in Step 4 by the number of hours available for initial heat up of the liquid. You now know how many kilowatts of heat are required for your installation.

For complete information on sizes and ratings of General Electric heaters, call your General Electric Apparatus Sales Office or send coupon below.

DELIVERY TODAY: Popular sizes of General Electric heaters are available today from General Electric stocks near your plant.

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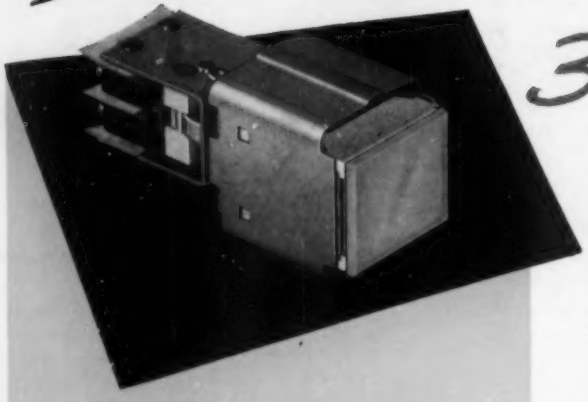
GENERAL ELECTRIC

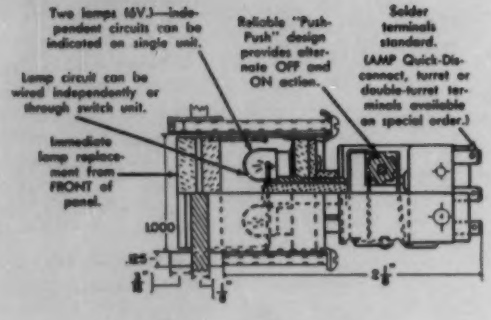
New ELECTRO SNAP "PUSH-ON, PUSH-OFF"

ALTERNATE ACTION LIGHTED PANEL SWITCH



3 units in 1 compact mounting; use singly or in "stacked" arrangement

The compact, modular design of this new Electro-Snap "Push-Push" alternate-action, panel-mounted switch combines a two-piece, color-coded button, pilot light and switching unit in one space-saving component. Two or more units may be "stacked" side-by-side in one panel slot. This eliminates congestion while achieving greater operating efficiency and quality appearance than where *separate* button, light and switch units are used.


Two lamps (6V.)—independent circuits can be indicated on single unit.
Reliable "Push-Push" design provides alternate OFF and ON action.
Solder terminals standard. (AMP Quick-Disconnect, turret or double-turret terminals available on special order.)
Lamp circuit can be wired independently or through switch unit.
Immediate lamp replacement from FRONT of panel.
.1000
.125
2½"

STANDARD MODELS (C6-Series)
Lighted Push-Button Panel Switches

Standard models furnished with two-piece colored button, two 6V. lamps, two basic switches (E4-103) with solder terminals.

C6-53—(shown above)—"Push-Push", alternate action.

C6-52—Momentary action with over-centering device, positive feel.

C6-51—Momentary action.

Model C6-50 — for pilot light duty only. Consists of 2-piece colored button and lamp unit with two 6V. lamps. (No switching mechanism).

- **2-piece color-coded button; 5 colors available.**
- **Barriers ordered separately — to meet panel requirements.**
- **28V. lamps available on special order.**

BASIC SWITCH OPERATING CHARACTERISTICS

Contact Arrangement	D.P.D.T.
Travel	3/32 Approx.
Contact Pressure	60 Grams
Contact Gap	.020 Max.
Temp. Range	−65° F to +180° F.
Current Rating	5A @ 125/250 V.A.C.
	4A Res @ 30 V.D.C. 2.5A Ind @ 30 V.D.C.

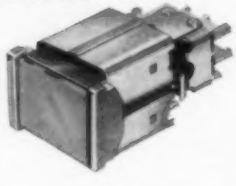
Wide range of configurations permits almost unlimited application for control and indicating operations.

Almost unlimited operating and indicating conditions can be provided for sequencing, movement-limit, start-and-stop and similar applications on missile, electronic and industrial controls through variation of:

- **circuit arrangements of switch and pilot lights**
- **colored lights for color monitoring**
- **colored push-buttons for color coding**

For full application details and specifications contact your local representative or write for data on Standard (C6 Series) Electro-Snap "Push-Push" Panel Switches.

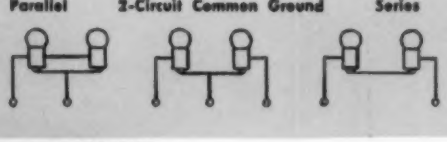
MOMENTARY-CONTACT **PUSH-BUTTON PANEL SWITCH**



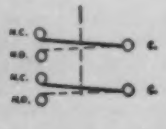
This momentary-contact, lighted push-button panel switch (C6 Series) has the same space-and-cost-saving features as the "Push-on Push-off" switch above. It is available in various configurations to permit application to a wide range of indicating and switching operations.

For details, write for "Bulletin CB"

- **Complete push-button switch unit or pilot-light assembly can be supplied in any of the three following circuit arrangements. (solder terminals on lamp assembly).**



- **The double-pole, double-throw switching unit may be wired normally-open or normally-closed.**



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